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ABSTRACT

The papers in this collection of 71 individual papers and 3 symposiums represent some of the most current thinking in educational communications and technology. For the first time, a selected number of development papers sponsored by the Division for Instructional Development are included. Topics discussed include the effects of various conditions on the learner and learning, including aptitude treatment interactions; learning strategies; teacher planning; instructional design and development; teaching strategies; the teacher's role; teacher education; research methodology; networking; computer-assisted instruction; hypermedia; distance education; teleconferencing; interactive video; computer simulations; and the instructional environment. The three symposiums focused on ethics, social considerations in educational computing, and the significance of the Channel One experiment. While research reports predominate, some reviews of the literature and opinion papers are included. This volume also includes a list of Research and Theory Division officers; a list of the reviewers of the papers for the conference; a list of proceedings from the year 1979 together with their ERIC document numbers; a description of the Association for Educational Communications and Technology (AECT) and a membership enrollment form; a table of contents; and author and descriptor indexes. (BBM)

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14th ANNUAL PROCEEDINGS of SELECTED RESEARCH AND DEVELOPMENT PRESENTATIONS

at the 1992 Convention of the
Association for Educational Communications and Technology
Sponsored by the Research and Theory Division
in
Washington, D.C.

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PREFACE

For the fourteenth year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is sponsoring the publications of these Proceedings. Papers published in this volume were presented at the national AECT Convention in Washington, D.C. A limited quantity of this volume were printed and sold. It is also available on microfiche through the Educational Resources Information Clearinghouse (ERIC) system.

REFEREEING PROCESS: All research papers selected for presentation at the AECT convention and included in this Proceedings were subjected to a rigorous blind reviewing process. Proposals were submitted to Steven Ross and Gary Morrison of Memphis State University or Gary Anglin of the University of Kentucky. All references to author were removed from proposals before they were submitted to referees for review. Approximately fifty percent of the manuscripts submitted for consideration were selected for presentation at the Convention and for Publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

For the first time, a selected number of development papers sponsored by the Division for Instructional Development (DID) are included in this Proceedings. The most important instructional development presentations were selected by the DID program chairs for publication.

This volume contains two indexes. The first is an author index; the second is a descriptor index. The index for volumes 1-6 (1979-84) is included in the 1986 Proceedings, and the index for volumes 7-10 is in the 1988 Proceedings.

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YEAR	LOCATION	ED NUMBER
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1980	Denver	194061
1981	Philadephia	207487
1982	Dallas	223191 to 223236
1983	New Orleans	231337
1984	Dallas	243411
1985	Anaheim	256301
1986	Las Vegas	267753
1987	Atlanta	285518
1988	New Orleans	295621
1989	Dallas	308805
1990	Anaheim	323912
1991	Orlando	334969

Association for Educational Communication and Technology

What is AECT?

AECT is the only national, professional association dedicated to the improvement of instruction through the effective use of media and technology. AECT assists its members in using technology in their jobs and to enhance the learning process.

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☐ Learning resource specialists
☐ Curriculum developers
☐ Television producers and directors
☐ Communications specialists
☐ Education administrators
☐ Others who require expertise in instructional technology

AECT History

AECT began as the Department of Audio-Visual Instruction at the National Education Association in 1923, in the days when visual aids were blackboards and easels. In 1947, as educators were adapting technology used to train World War II service personnel for the classroom, the name of the organization became the Department of Visual Instruction (DAVI). Twelve years later, DAVI became an affiliate of the NEA and finally the autonomous association, AECT, in 1974.

Today, AECT keeps an eye on the future of instructional technology while assisting educators with the changes and challenges that face them now. AECT members are professionals devoted to quality education. They care about doing their jobs better and want to ambrace new methods, new equipment, and new techniques that assist learning.

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AECT has 45 state and 11 national affiliates, and has recently established several chapters surrounding major universities and metropolitan areas. These affiliated organizations add a localized dimension to your AECT membership and allow for more interaction among your colleagues. For more details on chapters and affiliates in your area, contact the AECT National Office.

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Each year, AECT brings top speakers to exciting locations, and presents over 300 sessions and special events to provide the best training available in the use of media in education and instruction. The convention features the INFOCOMM International Exposition , an extravaganza of over 300 companies showing the latest products to use in education and training.

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Title:

ID Knowledge Structure, Lesson Planning and Teacher Performance

Author:

James M. Applefield

ID Knowledge Structure, Lesson Planning and Teacher Performance

Considerable interest has been expressed recently among professors of instructional design regarding the potential contributions of their field for practicing teachers. Calls for including ID skills in programs of teacher training can be found in various writings (Bielby 1974; Stolovitch, 1980; Earle, 1985; Dick & Carey, 1985; Dick and Reiser, 1989; and Klein, 1991). Several undergraduate programs now include more substantive treatments of instructional design (albeit, adapted for teachers), rather than the very incomplete treatment that typically occurs in preservice teachers' obligatory course in Educational Psychology.

While recommendations for teaching teachers a systems approach to instruction, which would include associated ID concepts, processes and skills, is certainly logically defensible, research to support the efficacy of such an approach in the typical planning routines and subsequent instruction of teachers is lacking. The evidence that does exist is based on the literature of teacher thinking and planning (Yinger, 1979; McCutcheon, 1980; Clark & Peterson, 1986; Brown, 1988), and it consistently indicates that most teachers engage in a planning process that is incongruent with significant aspects of generic ISD models. Teachers do not typically report the use of the linear rational planning model that characterizes models for the systematic design of instruction. Such findings present a challenge to the field of instructional systems design and to those who wish to promote beneficial applications of instructional design principles to preservice and inservice teachers .

In the teacher training program at the University of North Carolina at Wilmington, all students must take a course in instructional design, and a course in evaluation, and earn a grade of C or better in each. The undergraduate ID course teaches a systems approach to instruction using an adaptation of Dick and Carey's ID model, and emphasizing Gagne's taxonomy and events of instruction. Although all students complete the two-course sequence, some variability can be expected among students' cognitive and attitudinal learning outcomes, and in the ways that these learnings are organized and internalized. Satisfactory performance on the discrete intellectual skills and verbal information components of courses may belie possibly serious deficiencies in mastery of the higher level cognitive structure of the course or topic on the part of some students. Such deficiencies may reflect misconceptions within the knowledge structure formed by students, even among those earning the same course grade.

Thus, a course exit task which allows students to represent their own cognitive structure for ID concepts, principles, and relationships may better reveal students' degree of acquisition of the deep structure of the discipline than end-of-course grades (Novak & Gowin, 1984; Jonassen, 1987; Wallace & Mintzes, 1990). Fortunately there are a variety of mapping strategies that have been described and evaluated (Jonassen, Beissner, Kenny, Jost, Reid, & Yacci, 1990; Yacci 1990).

Gaining insight into preservice students' knowledge structures for ISD could improve our understanding of the ways in which they subsequently utilize this knowledge for teacher planning. If there are qualitative differences in students' conceptions of an ISD approach to instruction, they might be related to overall teacher performance.

The following study was conducted to address these questions. First, can preservice teachers' knowledge structure of ISD concepts, principles and attitudes be evaluated? Second, are preservice teachers who have an accurate conceptualization of instructional design (knowledge structure) more likely than those with weak knowledge structures to adopt a process for planning instruction that is more consistent with ISD models? Third, are teachers who implement more elements of ID in their instructional planning judged to be more effective teachers? Fourth, what do student teachers report about their beliefs regarding the efficacy of ISD principles for planning and delivering instruction and how they actually apply them?

METHOD Subjects were preservice teacher interns at the University of North Carolina at Wilmington. All had completed a course in instructional design and a course in evaluation with a grade of C or better. In the research reported here, Novak and Gowin's (1984) cognitive mapping task has been partially modified (see Strahan's semantic ordered trees, 1989). A recent study by Beyerback and Smith (1990) demonstrated the feasibility of using cognitive mapping tasks to measure changes in preservice teachers' conceptions of broad topics (effective teaching). Subjects were given a set of 27 starter words relating to teacher planning, and a set of 14 linking verbs/ phrases and were asked to create a cognitive map.

STARTER WORDS: attitude, classroom management, events of instruction, formative evaluation, individual differences, individualized instruction, instructional program, instructional strategies, intellectual skills, large group, learning outcomes, lesson plans, mastery learning, mental plans, media, motivation, objectives, remediation, revision, routines, subskills, tests, textbooks, transfer of learning, transitions, unit plans, verbal information.

LINKING VERBS/PHRASES: is subordinate to, is example of, is similar to, is needed for, is based on, takes place when, helps, comes before, occurs simultaneously with, involves, leads to, facilitates, affects, indicates that.

After reviewing examples of 3 cognitive maps and practicing by creating two simple cognitive maps (of dogs and classroom), the interns were asked to prepare a cognitive map for Teacher Planning. Subjects were instructed to use as many or as few of the starter words and linking phrases as they desired and to feel free to add whatever concepts they deemed important to express their conception of teacher planning.

Six students completed a cognitive mapping task on teacher planning during the summer prior to student teaching. After student teaching they constructed a second cognitive map of teacher planning and completed a questionnaire on teacher planning. Six additional fall semester teacher interns also completed the questionnaire. Student exit performance was determined by grades in student teaching and by university supervisors' summative evaluation checklists.

Qualitative evaluations were used to judge the sophistication of knowledge structure for teacher planning represented in the cognitive maps. The following criteria were used: a) number of concepts used, b) number and coherence of items per cluster, c) validity of relationships specified, d) comprehensiveness or number and significance of concepts included/omitted, and e) the narrative statements that accompanied each map.

RESULTS There was considerable variability in the sophistication and stability of the cognitive maps, as well as in the degree of change from pre- to post-administration of the mapping task. Three students' pre-and post-maps have been selected for discussion (see Figures 1, 2 and 3). Maps 1A and 1B reveal a good understanding of the fundamental precepts of instructional systems design. They exhibit good detail and are well organized. Map 1A addresses the relationships among the major aspects of planning and emphasizes individual differences. In map 1B one sees a more streamlined rendition of teacher planning. Classroom management is now portrayed as one of three critical dimensions in planning, along with the dimension of individualized instruction. This map does portray a systematic planning approach and conveys a heightened awareness and urgency regarding the individual learner and the environmental context of learning in schools. Concern for the classroom environment is a salient feature, as expressed by the statement, "... should be comfortable; children should be able to ask questions and take risks. The class should be success oriented."

In map 2A one finds that a large number of planning concepts have been included, but the relationships among these concepts are not clearly made. The main organizing frame for this map is events of instruction, but it is not entirely clear how this concept is being used. In short, the process of planning is not revealed, nor is there any indication that an instructional systems design model is operating to coordinate thinking about planning. In the post- student teaching map (2B), the dominant organizer of planning concepts has shifted to mental plans. Once again terms are simply classified into groups that share some reasonably common theme. The poor articulation in the supplemental narratives for these maps is consistent with the conclusion that maps 2A and 2B exhibit a much more limited view of teacher planning and give little evidence of an understanding of instructional systems design.

> 2A: Teacher planning consists of many components. It is important that the instructional program, instructional strategies, lesson plans, mental plans and individual instruction all be a part of the events of instruction. The instructional program should be integrated. If it is integrated the learning outcomes will flow...
>
> 2B: Start off with mental plans - big areas of starting off: events of instruction, instructional program, lesson plans, management, revisions and evaluation. Then I have each subdivision broken down with what should be included.

In Maps 3A and 3B we see a highly systematic process of planning and abundant evidence of the application of the essential elements of ISD. The importance of making revisions is a prominent feature of map 3A, as is an apparently greater emphasis on planning for classroom management within the overall context of teacher planning. Map 3B has been transformed into more of a flowchart for planning beginning with global or year-long plans. The revision process continues to be viewed as critical to planning as does the essential contributions of classroom management and learner characteristics (including attitudes and motivation) to planning decisions (instructional strategies, selection of materials and media, and application of events of instruction). This student's narrative reveals the prominence of ISD principles in her approach to planning for instruction as well as the tentative nature of planning for a class of third graders:

> Teacher planning is a complex part of this profession. It is also not something that can be done once and that's it. Planning is a process which often requires revision. New thoughts are generated daily by what you've seen your students do. I found myself constantly questioning my objectives, strategies and evaluation measures to see if I was providing for all children's success in the classroom. After reviewing the state curriculum guide and establishing year long goals, I was then able to generate a six week plan of instruction. My daily plans were then derived from the six weeks plan. I selected my objectives and asked myself questions about expected learning outcomes. Then keeping my students' learning styles in mind, I designed instructional strategies for providing a learning rich lesson. Most of my plans included cooperative learning activities. Following instruction I used the test initially designed in the planning process. If I altered or revised during any stage, my tests also were revised. I constantly tried to transfer the children's knowledge and searched for ways to make this knowledge most meaningful in their lives.

Each student was supervised and evaluated by one of three university faculty members. Five of the student teachers received a grade of 'A' in the student teaching course; the other student received a 'B'. The student teacher whose cognitive maps (2A and 2B) were judged to be least sophisticated received a grade of 'B'. All students were rated excellent in the function of Planning for Instruction. Since there was minimal variability in the ratings and grades of the six teachers, no relationships could be established between these outcome measures and differences detected in the sophistication of cognitive maps.

QUESTIONNAIRE RESULTS There were differences between the patterns of responses of the 6 interns who taught in either a kindergarten or first grade class (kdg-3; 1st- 3), and the 6 interns who taught in the third grade (3), fourth grade (2) or fifth grade (1). Consequently, the average ratings (1-5) for each of the 18 questionnaire items are summarized separately for these two groups. See Table 1.

Teachers in K-1 classes expressed strongest agreement with items: 8. (...mindful to take account of prerequisites in planning and sequencing instruction); 11 (There is an essential relationship among objectives, instruction and evaluation); 12 (... much of teacher planning is never put on paper); 13 (... one can think in terms of types of learning outcomes without actually writing down behavioral objectives); and 16 (... planning begins with a mental conception of an objective, not a behavioral objective). These primary grade teachers were very emphatic about the idea of planning without putting their thought s in writing (4.67). They expressed slight disagreement with the following items: 1 and 2 (... my study of Gagne's events of instruction has helped me to plan effective instructional activities; deliver effective instruction); 4 (... my study of Gagne's taxonomy of learning has helped me to deliver effective instruction); 9 (I am careful in planning lessons to include the appropriate events of instruction that apply to the domain of learning being taught); 10 (...I incorporate the external conditions of learning that are relevant to the domain of objectives in the lesson); and 14 (What I write in my lesson plans is almost always translated into what actually occurs when I teach). It is also noteworthy that the K-1 teachers indicated slight agreement with item 18 (I really have not found the instructional design concepts and skills to be that relevant to teaching).

While the perceptions of both groups were quite similar for many items, disparities were observed for other items. Teachers of grades 3, 4 or 5 also indicated strongest agreement with items 8, 11, 13, and 16 (see above). However, a discrepancy was observed between the responses of the two groups of teachers for items 1, 2, 4, 9, 10, 12, and 18. Overall there was a tendency for grades 3-5 teachers to report more application of ISD principles, to view more positively the contributions of their coursework in instructional design to their planning and teaching, and to be less adamant in the view that much of teacher planning is never put on paper.

Additional responses to open ended questions revealed that the preservice teachers used a comprehensive approach to the planning function of teaching. In one intern's words:

> Teacher planning is a very complex process. As a teacher you have to know your students' individual strengths and needs. You have to develop strategies to teach concepts according to those needs (positive planning); evaluate and re-evaluate strategies; study knowledge you want to teach, know prior knowledge that is needed in order to learn new info. What you want your children to learn should be noted (process and product you would like to see) and then evaluate to see if this happened...

A potentially important insight into another facet of certain teachers' planning is conveyed by this response to the question, "Did the way in which you used objectives in your general planning and specifically in your written lesson plans change over the course of your student teaching semester?:

> When integrating our subjects we would first pick out the concept we felt to be important and those we wanted to teach. Through those concepts we developed our goals, objectives, activities, etc. For example the concept, 'conflict': Social Studies - Revolutionary War; Math - Math Sandwich Shops; Health : Independent Me; Literature -Mrs. Frisby and the Rats of Nimh.

The thematic approach to teaching described here seems to place more emphasis on the goal of achieving interdisciplinary learnings. It suggests a more holistic , less discrete view of the outcomes of instruction. The whole language approach that is currently widely advocated for teaching the language arts curriculum is yet another example of a general teaching methodology embedded in a philosophy of teaching and learning that emphasizs the integrated, holistic, constructivist nature of learning.

The essential nature of mental planning either in tandem with or in lieu of more formal written lesson planning was repeatedly underscored. Here are three responses to the questions: "Do you engage in mental planning? Describe how you do this type of planning.

> Mental planning takes up to 75% of your time if you are interested or concerned about how you teach. A continual recording in your mind runs about how students will react, what you need to remember, etc.

Another teacher expressed it this way:

> I would say that I am always mentally planning but I am a person who has to put things on paper in order for them to make sense. ...I was constantly revising and editing my plans. It is a constantly changing situation that almost forces one to plan with every free moment's thoughts.

And this teacher's comment underscores the importance of mental planning and the urgency (or perhaps , impatience with planning) that some teachers bring to their work:

> Yes, most definitely - I can explain things verbally much better than trying to write down what all I'm thinking about. I think about an objective, or task which must be performed, learned. Form different activities that would enhance this learning. Write them down. Form a type of test idea that would show how much learning has occurred. Then make notes - Do it!

DISCUSSION What emerges from these data is a picture of teachers who are planful, organized and very concerned, as one would expect, with the most salient aspects of teaching: a) the learners, and b) the teaching activities - with getting the work done. While there were several comments made about the inefficiency and questionable utility of writing detailed objectives or detailed lesson plans, these preservice teachers made many references to their use of objectives in planning. They are very cognizant of the complexities of their work and of the necessity of taking into account a number of critical variables when planning. Although they may not consistently plan according to a linear ID model, most reported that they systematically considered crucial planning variables and in general described their mental planning in terms of a systems view of teaching. For example, consider this intern's statement:

> I feel strongly that a teacher has to plan very diligently for the students to be successful. However, I don't feel that an objective has to be written in a formal form for learning to take place. Maybe I do things backwards - I always think about my students' learning and where I want them to go and what I want them to get out of it, but (as I sit back) I think I just do it in a different order.

Thiagarajan (1976) makes a similar point in arguing for the acceptability of a more flexible application of the systems approach to the design of instruction. This seems particularly appropriate for the fluid world of the classroom teacher.

Several other findings are noteworthy. At least during the highly self-conscious period of their student teaching experience, these interns incorporate some aspects of formative evaluation. This is evidenced by their propensity for regular reflection on their instructional successes and mishaps; and a readiness, if not a definite expectation, for revising their instructional activities. Also, written objectives give way to time constraints and to the primacy of mental planning, with brief notes being used as cues for teaching. Lastly, it is quite apparent that the preservice teachers in this small sample consistently placed a high premium on attending carefully to their learners as they engaged in the process of planning. As one student remarked, "I determine the needs of the student and seek to engage in learning activities that will effectively meet those needs."

To better understand these preservice elementary teachers' overriding concern for learner characteristics, it is relevant to recall Walter Dick's observation (1981) in an article about future trends and issues in instructional design:

> Most instructional design models are intended to have broad application. Therefore, they are not specific to any content or to any particular set of learners or instructors. As such, instructional design models (and instructional designers) sometimes give the appearance of ignoring the role of the student and the teacher in the learning process. It may be hypothesized that in the decade ahead there will be more emphasis on the people who implement the learning system. Emphasis will be manifested in terms of a greater knowledge of the general characteristics of the learners who are being served - their motivations, their learning habits, and their preferences. Designers will avoid the stereotypes of learners and work directly with them. (p.32)

This prediction for instructional designers may in fact characterize the everyday reality of elementary school teachers. Certainly the image that emerges of preservice elementary education teachers from their cognitive maps and from self-reports of their mental planning behavior constitutes a strong affirmation of Dick's earlier insight.

One certainly gains a renewed appreciation of the complex and cognitively demanding nature of good teaching. Teacher planning is without question a broad and complex topic that requires the integration of a number of elements including lesson planning. In conceptualizing planning, teachers must consider how they integrate all of the complexities of a classroom environment as they grapple with how to arrange the conditions and experiences to best promote the learning of diverse students.

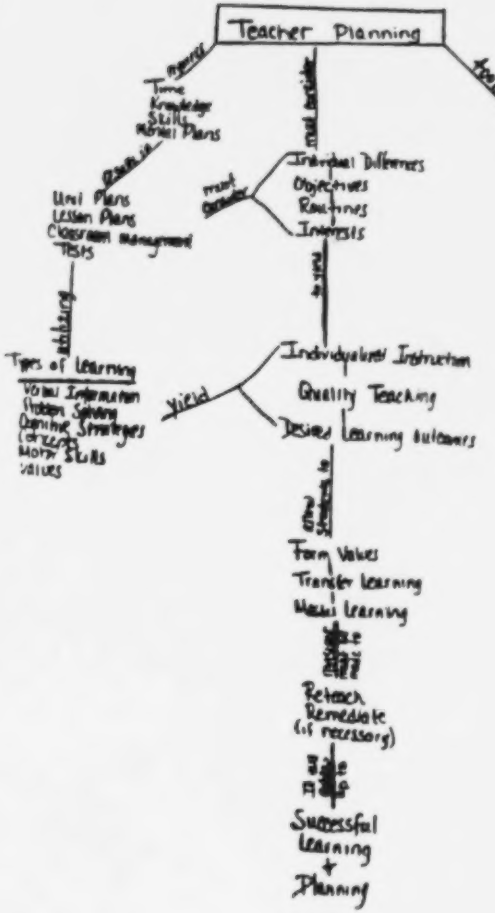
It is gratifying to see that most of these novice teachers' cognitive maps and self-report data reveal a systematic quality to their planning behavior. The language of several of these teachers, but certainly not all, is consistent with the principles and general process of ISD. It would be desirable to conduct a more finegrained analysis of the qualitative differences in how teachers plan, and to also search for relationships between teachers' planning and student outcome variables.

What is also of interest is that several students claimed not to see much benefit from having studied instructional systems design. This was the case even for some students whose descriptions of their own behavior indicated that they *were* indeed applying a basic ISD model in their planning. How to reconcile the perception that ISD principles lack utility for them as teachers is a puzzle. Perhaps some students confuse form with process, that is, they come to see an ISD model and the formal planning and products of their instructional design classes as the form that they must attempt to emulate rather than a process that can guide their thinking and planning for instruction.

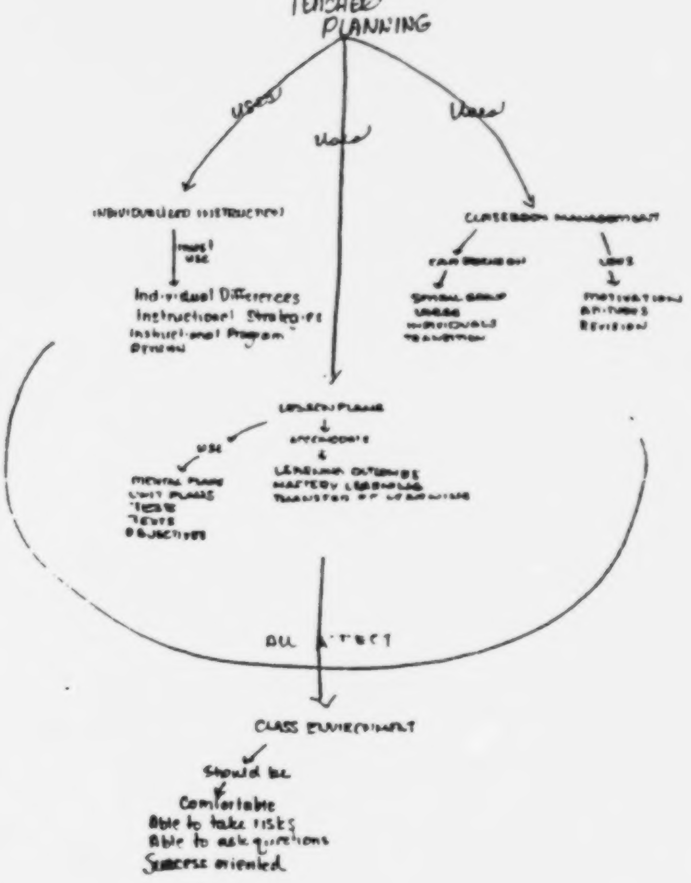
Reigeluth (1983) makes a distinction between instructional design theory and learning theory when he states that the former "...must include specific instructional method variables;" and is therefore relatively easy to apply in the classroom. On the other hand he claims that learning theory is typically difficult to apply because it lacks specificity and leaves it to the teacher to devise the specific applications of instruction. I believe this distinction, while somewhat overstated, has merit in aiding our understanding of why some teachers reject or claim to reject their training in instructional design.

We need to acknowledge and help preservice teachers understand that ISD can be a valuable tool if it is used as a heuristic for planning systematically, rather than being perceived as an absolute and mechanistic formula for instructional planning that is out of touch with the realities of their classrooms. In short, we must do a better job of translating and modifying the essential elements of the ISD process in order to make it efficient and effective for teachers at all levels, and compatible with teachers' perceptions of the imperatives of teaching.

FIGURE 1

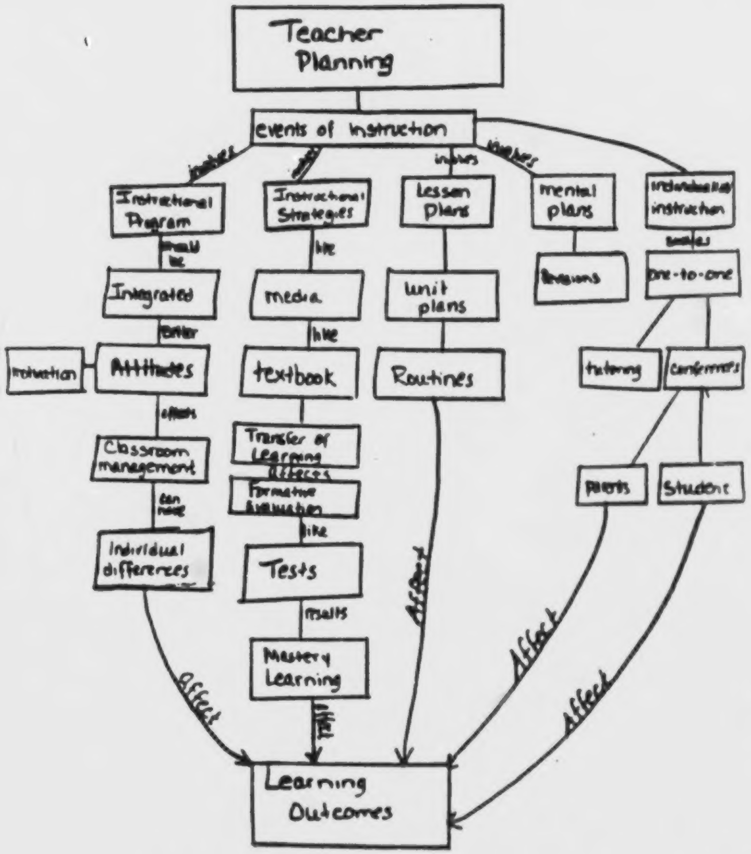

Teacher Planning
tools
Textbooks
Curriculum Guides
Resources
Various media
Time
Knowledge
Skills
Unit Plans
Lesson Plans
Classroom management
Tests
Individual Differences
Objectives
Routines
Interests
Types of Learning
Verbal Information
Problem Solving
Cognitive Strategies
Concepts
Motor Skills
Values
yield
Individualized Instruction
Quality Teaching
Desired Learning outcomes
Form Values
Transfer Learning
Mastery Learning
Reteach
Remediate
(if necessary)
Successful
Learning
+
Planning

Map 1a

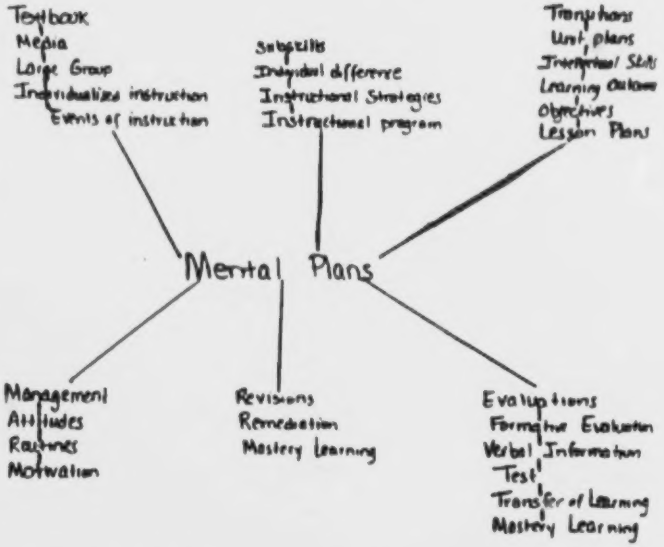

TEACHER PLANNING
uses
uses
uses
INDIVIDUALIZED INSTRUCTION
must use
Individual Differences
Instructional Strategies
Instructional Program
CLASSROOM MANAGEMENT
MOTIVATION
REVISION
LESSON PLANS
use
MENTAL PLANS
UNIT PLANS
TESTS
OBJECTIVES
MASTERY LEARNING
TRANSFER OF LEARNING
ALL AFFECT
CLASS ENVIRONMENT
Should be
Comfortable
Able to take risks
Able to ask questions
Success oriented

Map 1b

FIGURE 2


Teacher Planning
events of instruction
involves
includes
involves
involves
Instructional Program
Instructional Strategies
lesson plans
mental plans
individualized instruction
should be
like
enables
Integrated
media
unit plans
Revisions
one-to-one
foster
like
motivation
Attitudes
textbook
Routines
tutoring
conferences
effects
Classroom management
Transfer of Learning
Affects
Formative Evaluation
parents
Student
can have
like
Individual differences
Tests
results
Mastery Learning
Affect
Affect
Affect
Affect
Learning Outcomes

Map 2a

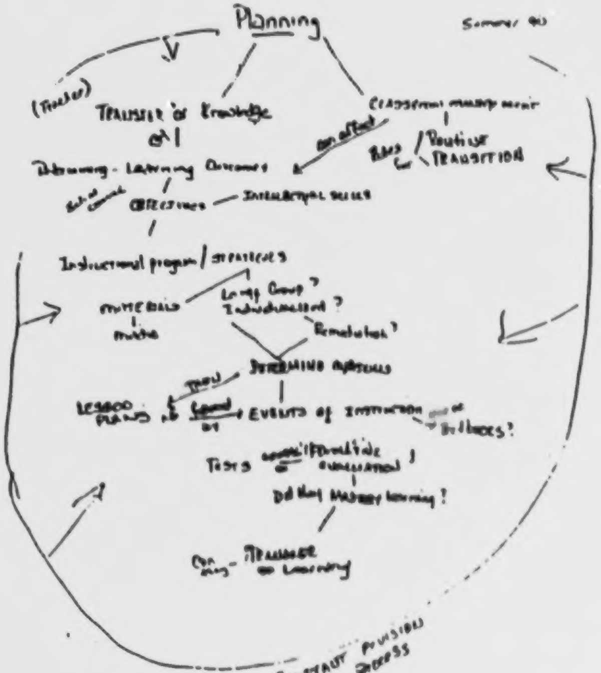

Textbook
Media
Large Group
Individualized instruction
Events of instruction
Subskills
Individual difference
Instructional Strategies
Instructional program
Transitions
Unit plans
Intellectual Skills
Learning Outcome
Objectives
Lesson Plans
Mental Plans
Management
Attitudes
Routines
Motivation
Revisions
Remediation
Mastery Learning
Evaluations
Formative Evaluation
Verbal Information
Test
Transfer of Learning
Mastery Learning

Start off with Mental Plans - Big areas of starting off. Events of instruction, Instructional Program, Lesson Plans, Management, Revisions and Evaluations. Then I have each subdivision broken down with what should be included.

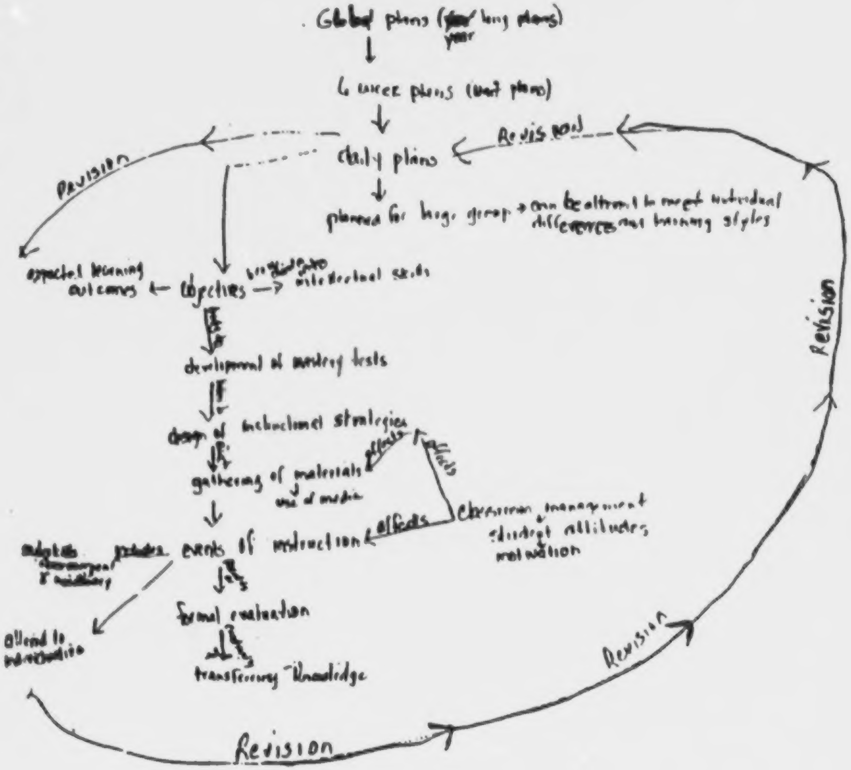
Map 2b

BEST COPY AVAILABLE

FIGURE 3


Planning
Summer 90
(Teacher)
Transfer of Knowledge
Determining - Learning Outcomes
Objectives — Intellectual skills
Instructional program / strategies
Materials
media
Large Group ?
Individualized ?
Remediation ?
Determining materials
Lesson Plans
Events of Instruction
Enrichment?
Tests
Formative / Summative evaluation
Did they master learning ?
Transfer of Learning
Classroom management
Rules / Routines for Transition
an effect
Constant revision process

Map 3a


Global plans (year long plans)
6 week plans (unit plans)
daily plans
planned for large group + can be altered to meet individual differences and learning styles
Revisions
Revision
expected learning outcomes
objectives
intellectual skills
development of mastery tests
design of instructional strategies
gathering of materials
use of media
events of instruction
affects
classroom management
student attitudes
motivation
formal evaluation
attend to individualization
transferring knowledge
Revision
Revision
Revision

Map 3b

TABLE 1

Item No.	k-1 Mean	3-5 Mean	Item No.	k-1 mean	3-5 mean
1	2.67	3.67*	10	2.83	3.83*
2	2.83	3.83*	11	4.50	4.83
3	3.17	3.50	12	4.67*	3.67
4	2.67	3.50*	13	4.33	4.00
5	3.50	3.50	14	2.67	3.83
6	3.67	3.67	15	3.17	3.83
7	3.17	3.33	16	4.33	4.00
8	4.33	4.67	17	3.67	3.33
9	2.83	3.67*	18	3.50*	2.33

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*Items 1, 2, 4, 9, 10, 12 and 18 are starred to indicate discrepancies between the means of the two groups of teachers. A significant difference (.05 level) was found for item 4 (t= 2.704).

References

Beyerback, B.A., & Smith, J.M. (1990). Using a computerized concept mapping program to assess preservice teachers' thinking about effective teaching. Journal of Research in Science Teaching, 27, 961-971.

Bielby, A.E. (1974). Instructionl development in the public schools - whose job? Educational Technology, 14, 11-16.

Brown, D.S. (1988). Twelve middle-school teachers' planning. The Elementary School Journal, 89, 69-87.

Clark, C.M., & Peterson, P.L. (1986). Teachers' thought processes. In M.C. Wittrock (Ed.), Handbook of Research on Teaching. New York: MacMillan Publishing Company.

Dick, W. (1981). Instructional design models: Future trends and issues. Educational Technology, 21, 29-32.

Dick, W. and Carey, L. (1985). The systematic design of instruction. (2ed) Glenville, IL: Scott Foresman & Co.

Dick, W. and Reiser, R.A. (1989). Planning effective instruction. Englewood Cliffs, NJ: Prentice-Hall.

Earle, R.S. (1985). Teachers as instructional designers. Educational Technology, 15, 15-18.

Jonassen, D.H. (1987). Assessing cognitive structure: Verifying a method using pattern notes. Journal of Research and Development in Education, 20, 1-14.

Jonassen, D.H., Beissner, K., Kenny, R., Jost, K., Reid, D., & Yacci, M. (1990). Conveying, assessing, and learning (strategies for) structural knowledge. In M.R. Simonson and C. Hargrave (Eds.) Proceedings of Selected Research Paper Presentations at the 1990 Convention of the Association for Educational Communications and Technology in Anaheim, California.

Klein, J.D. (1991). Preservice teacher use of learning and instructional design principles. Educational Technology Reserch & Development, 39, 83-89.

Martin, B.L., & Clemente, R. (1990). Instructional systems design and public schools. Educational Technology and Research and Development, 38, 61-76..

McCutcheon, G. (1980). How do elementary school teachers plan? The nature of planning and influences on it. The Elementary School Journal, 81, 4-23.

Novak, J.D. & Gowin, D.B. (1984). Learning how to learn. Cambridge: Cambridge University Press.

Reigeluth C.M. (1983). Instructional design: What is it and why is it? In C.M. Reigeluth (Ed.), Instructional-Design Theories and Models: An Overview of Their Current Status. Hillsdale, NJ: Lawrence Earlbaum Associates, Publishers.

Stolovitch, H.D. (1980). Instructional technology and its challenge to teacher training. Performance and Instruction, 19,17-19.

Strahan, D.B. (1989). How experienced and novice teachers frame their views of instruction: An analysis of semantic ordered trees. Teaching and Teacher Education, 5, 53-67.

Thiagarajan, S. (1976). Help, I am trapped inside an ID model! Alternatives to the systems approach. NSPI Journal, 15, 10-11.

Wallace, J.D., & Mintzes, J.J. (1990). The concept map as a research tool: exploring conceptual change in biology. Journal of Research in Science Teaching, 27, 1033-1052.

Yacci, M. (1990). Assessing knowledge structures. In M.R. Simonson and C. Hargrave (Eds.) Proceedings of Selected Research Paper Presentations at the 1990 Convention of the Association for Educational Communications and Technology in Anaheim, California.

Yinger, R.J. (1979). Routines in teacher planning. Theory into Practice, 18, 163-169.

Title:

The Effects of Two-Way Visual Contact on Student Verbal Interactions During Teleconferenced Instruction

Authors:

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Landra L. Rezabek

Rationale

Traditionally, audio teleconferencing has been a convenient method of bringing students together for distance learning (Wagner & Reddy, 1989). In addition audio teleconferencing, some colleges and universities have been experimenting with more sophisticated technologies that incorporate computer graphics (audiographic teleconferencing); full motion video distributed via satellite, cable, or microwave; and other less costly audio/video teleconferencing systems such as slow-scan or compressed video (Ritchie & Newby, 1989; Wagner & Reddy, 1989).

Developers of more sophisticated teleconferencing systems claim that these systems are superior to the traditional audio-conferencing systems because they offer the added benefit of visual contact among students and instructors which promotes interaction (dialogue) during instruction. The research upon which this claim is based is scarce, however, and the few studies that have addressed interaction have suffered from poor design.

Problem

Researchers investigated whether there was a difference in either the overall frequency or the frequency of specific types of student verbal interactions among the following three groups:
(a) teleconferenced instruction where students had two-way audio and video contact with the instructor,
(b) teleconferenced instruction where students had only two-way audio contact with the instructor, and
(c) traditional face-to-face instruction.

Hypotheses

This study was designed to test the following hypotheses:

1. The number of student verbal interactions that occur during teleconferenced instruction where students have two-way audio and video contact with the instructor will be greater than the number of student verbal interactions that occur during teleconferenced instruction where the students have only two-way audio contact with the instructor.

2. The number of student verbal interactions that occur traditional face-to-face instruction will be greater than the number of student verbal interactions that occur during teleconferenced instruction where the

students have only two-way audio contact with the instructor.

3. The number of student verbal interactions that occur during traditional face-to-face instruction will be greater than the number of student verbal interactions that occur during teleconferenced instruction where the students have two-way audio and video contact with the instructor.

4. The number of restricted thinking questions that students ask during teleconferenced instruction where students have two-way audio and video contact with the instructor will be greater than the number of restricted thinking questions that students ask during teleconferenced instruction where the students have only two-way audio contact with the instructor.

5. The number of restricted thinking questions that students ask during traditional face-to-face instruction will be greater than the number of restricted thinking questions that students ask during teleconferenced instruction where the students have only two-way audio contact with the instructor.

6. The number of restricted thinking questions that students ask during traditional face-to-face instruction will be greater than the number of restricted thinking questions that students ask during teleconferenced instruction where the students have two-way audio and video contact with the instructor.

7. The number of expanded thinking questions that students ask during teleconferenced instruction where students have two-way audio and video contact with the instructor will be greater than the number of expanded thinking questions that students ask during teleconferenced instruction where the students have only two-way audio contact with the instructor.

8. The number of expanded thinking questions that students ask during traditional face-to-face instruction will be greater than the number of expanded thinking questions that students ask during teleconferenced instruction where the students have only two-way audio contact with the instructor.

9. The number of expanded thinking questions that students ask during traditional face-to-face instruction will be greater than the number of expanded thinking questions that students ask during teleconferenced instruction where the students have two-way audio and video contact with the instructor.

10. The number of restricted thinking responses that students give during teleconferenced instruction where students have two-way audio and video contact with the instructor will be greater than the number of

restricted thinking responses that students give during teleconferenced instruction where the students have only two-way audio contact with the instructor.

11. The number of restricted thinking responses that students give during traditional face-to-face instruction will be greater than the number of restricted thinking responses that students give during teleconferenced instruction where the students have only two-way audio contact with the instructor.

12. The number of restricted thinking responses that students give during traditional face-to-face instruction will be greater than the number of restricted thinking responses that students give during teleconferenced instruction where the students have two-way audio and video contact with the instructor.

13. The number of expanded thinking responses that students give during teleconferenced instruction where students have two-way audio and video contact with the instructor will be greater than the number of expanded thinking responses that students give during teleconferenced instruction where the students have only two-way audio contact with the instructor.

14. The number of expanded thinking responses that students give during traditional face-to-face instruction will be greater than the number of expanded thinking responses that students give during teleconferenced instruction where the students have only two-way audio contact with the instructor.

15. The number of expanded thinking responses that students give during traditional face-to-face instruction will be greater than the number of expanded thinking responses that students give during teleconferenced instruction where the students have two-way audio and video contact with the instructor.

Significance of the Problem

Most of the research in distance education consists of comparisons between traditional on-campus courses and their distance counterparts (Ritchie & Newby, 1989). Verbal interaction is rarely reported in these intermedia studies; in fact, student/teacher verbal interaction is often not permitted during instruction in order to avoid introducing an uncontrollable variable (Salomon & Clark, 1977).

Evidence suggests that students' perceived achievement and affect towards the subject and instructor are related to student/teacher interaction. When high levels of verbal interaction are present, students report that they learn more and enjoy the experience more than situations that involve low levels of student/teacher interaction (Richmond, Gorham, & McCroskey, 1987; Gorham, 1988).

During audio teleconferences, nonverbal interaction is not transmitted between remote sites; however, during video teleconferences this nonverbal information is transmitted. Research by Wiener and Mehrabian (1968) and Mehrabian (1971, 1972) suggests that some of this nonverbal information has the potential of inducing verbal interaction. Since verbal interaction is considered to be desirable during instruction, one could make a case for developing and utilizing distance delivery systems that provide optimum potential for two-way student/teacher interaction. In order to do so, such systems would require two-way video capabilities in order to transmit nonverbal information among remote sites. These systems are expensive and require significant human resources to manage and maintain. Institutions must be convinced that the benefits are worth the costs before investing these resources. By measuring the benefits in terms of the potential for student/teacher interaction rather than exam scores and course grades, the benefits may, indeed, justify the costs.

Methods and Procedures

One-hundred seventy-two subjects enrolled in four separate sections of Classroom Educational Technology (ET 401), during the Fall semester, 1991 at the University of Northern Colorado took part in the study. All of the students enrolled in ET 401 were Professional Teacher Education (PTE) students, meaning that they were pursuing teacher certification in Colorado.

There were four separate sections of ET 401, each containing about forty-three students. Within each section, students were randomly assigned to one of three treatment groups. In other words, within each of the four sections of ET 401 there were three treatment groups, each containing about fourteen students. After the treatments were conducted, the results of the four separate sections of ET 401 were collapsed for data analysis, resulting in three larger treatment groups of approximately fifty-seven students each.

The selected site for this study was the University of Northern Colorado (UNC) College of Education and College of Continuing Education. Two-way audio and video teleconferencing facilities exist between the Western Institute of Distance Education

(WIDE) conference room and Frasier Hall, both located on UNC's Greeley campus. The instructor taught from the Frasier Hall site and the students were located in the WIDE conference room except for the traditional face-to-face treatment where the instructor was physically present in the WIDE conference room with the students. Each location was equipped with 26" monitors, conference tables and seating to accommodate about twenty students, plus all of the necessary hardware and software in order to operate either a two-way audio-only teleconference, or a two-way audio and video teleconference.

Treatment Group A received instruction delivered via two-way audio teleconference (audio group). Treatment Group B received instruction delivered via two-way audio-video teleconference (audio/video group). Treatment Group C received instruction delivered in a traditional face-to-face manner with the instructor present in the WIDE conference room with the students (traditional group).

Each group of fourteen students met twice in the WIDE conference room during regular class hours. The first meeting was designed to desensitize the students to the newness of the instructional situation. No data were collected during this first session. The first lesson was entitled "Topics in Distance Education." The second lesson was entitled "Copyright Issues for Using Videotapes in the Classroom."

The formats of the two lessons were very similar. The instructor gave the students handouts with a series of true/false questions designed to stimulate thinking on the subject. Students completed these questions and the instructor went over the answers. The instructor then presented the new information. Students were told to interrupt if they had questions or comments. A series of open-ended questions and short case studies were then presented. The instructor read the question or case and then called for comments. A standard wait time of five seconds was used during all instruction. If students did not respond, the instructor would issue one more call for responses and wait an additional five seconds before moving on to the next question or case. For both lessons, students were given handouts with outlines, discussion questions, and cases.

The second lesson on copyright issues was videotaped, and the videotapes were reviewed and coded by two independent consultants according to the following Equivalent Talk Categories (ETC's): (a) restricted thinking questions, (b) expanded thinking questions, (c) restricted thinking responses, and (d) expanded thinking responses (Ober, Bentley, & Miller, 1971).

Results

A series of one-way ANOVA's and Dunn's t-tests were conducted for each of the equivalent talk categories to determine whether there were differences among the three treatment groups (see Tables 1-10). The following summarizes the results for each of the equivalent talk categories.

Total Number of Student Responses

An F value of 9.09 indicated that there were significant differences among the three groups in total number of student responses. The difference between the means of the audio and audio/video groups was .0946 (see Table 2). This difference was not large enough to yield significance at the .05 level. The difference between the audio and traditional groups, however, was 2.62, indicating significance. The traditional group interacted more than the audio group in this category.

Dunn's t-test also yielded significance between the audio/video group and the traditional group (difference between means = 2.72). The traditional group interacted more than the audio/video group in terms of the total number of interactions given during the lesson (see Tables 1 and 2).

Table 1
ANOVA Summary Table for Total Number of Student Responses by Group.

Source	df	SS	MS	F
Between Groups	2	270	135	9.09**
Within Groups	169	2510	15	
Total	171	2781		

*p < .05
**p < .01

Table 2

Dunn's Test for Total Number of Responses by Group

Group Comparison	Difference Between Means
A & B	0.0946
A & C	2.6216*
B & C	2.7163*

*Significant at .05

Restricted Thinking Questions

An F value of 4.02 indicated that there were significant differences among the three groups in this category. Dunn's t-test revealed that there was no difference between the audio group and the audio/video group. Also there was no difference between the audio group and the traditional group. Students in the traditional group, however, initiated more restricted thinking questions than students in the audio/video group. The difference between the group means was .35, indicating significance at the .05 level (see Tables 3 and 4).

Table 3

ANOVA Summary Table for Restricted Thinking Questions by Group

Source	df	SS	MS	F
Between Groups	2	3.41	1.71	4.02*
Within Groups	169	71.81	0.42	
Total	171	75.23		

*p < .05

**p < .01

Table 4

Dunn's Test for Restricted Thinking Questions by Group

Group Comparison	Difference Between Means
A & B	0.0111
A & C	0.2945
B & C	0.3056*

*Significant at .05

Expanded Thinking Questions

In the expanded thinking response category, students in the traditional group interacted significantly more than students in the video teleconference group (F = 3.37) (see Table 6). The audio and the audio/video groups did not differ significantly, with differences in group means of .13. The difference between the audio and traditional group of .14 was not large enough to indicate significance in this category (see Tables 5 and 6).

Table 5
ANOVA Summary Table for Expanded Thinking Questions by Group

Source	df	SS	MS	F
Between Groups	2	5.71	2.86	3.37*
Within Groups	169	143.28	0.85	
Total	171	149.00		

*p < .05
**p < .01

Table 6
Dunn's Test for Expanded Thinking Questions by Group

Group Comparison	Difference Between Means
A & B	0.1354
A & C	0.1386
B & C	0.4325*

*Significant at .05

Restricted Thinking Responses

A large F value of 10.35 showed that there were significant differences among the three groups in this category. The audio group gave significantly fewer restricted thinking responses than the traditional group (difference between means = 1.19). The audio/video group also gave significantly fewer responses than the traditional group (difference between means = 1.29). No significance was indicated between the audio group and the audio/video group in this category (see Tables 7 and 8).

Table 7
ANOVA Summary Table for Restricted Thinking Responses by Group

Source	df	SS	MS	F
Between Groups	2	59.15	29.57	10.35**
Within Groups	169	482.97	2.86	
Total	171	542.12		

*p < .05
**p < .01

Table 8
Dunn's Test for Restricted Thinking Responses by Group

Group Comparison	Difference Between Means
A & B	0.1039
A & C	1.1917*
B & C	1.2956*

*Significant at .05

Expanded Thinking Responses

The final category tested was expanded thinking responses, and an F value of 3.55 indicated significance at the .05 level among the three groups. Dunn's t-test showed that there was a significance difference between the audio group and the traditional group--the traditional group gave more expanded thinking responses than the audio group (difference between means = .80). No differences were indicated between the audio and audio/video groups, nor between the video and traditional groups (see Tables 9 and 10).

Table 9
ANOVA Summary Table for Expanded Thinking Responses by Group

Source	df	SS	MS	F
Between Groups	2	20.88	10.44	3.55*
Within Groups	169	496.77	2.94	
Total	171	517.65		

*p < .05
**p < .01

Table 10

Dunn's Test for Expanded Thinking Responses by Group

Group Comparison	Difference Between Means
A & B	0.1180
A & C	0.8005*
B & C	0.6825

*Significant at .05

Implications and Recommendations for Further Study

The results of this study indicated that students were not likely to interact more during teleconferenced instruction where students had two-way audio and video contact with the instructor than they would during teleconferenced instruction where students had only two-way audio contact with the instructor. As a result Hypothesis 1 was rejected at the .05 level. The results indicated that students were likely to interact more during traditional face-to-face instruction than they would during either an audio only or an audio/video teleconference. These findings were consistent with Hypotheses 2 and 3.

In the specific Equivalent Talk Categories (ETC's), the control group asked significantly more questions--both in the restricted and expanded thinking categories--than the audio/video group. These findings were consistent with Hypotheses 6 and 9. The audio group and the traditional group, however, did not differ significantly in these ETC's. As a result, Hypotheses 4 and 7 were rejected at the .05 level. Also, there were no significant differences between the audio and the traditional group in either restricted or expanded thinking questions; consequently, Hypotheses 5 and 9 were also rejected at the .05 level. Further research needs to be conducted to determine exactly why the predictions given in Hypotheses 4, 5, 7, and 8 did not materialize.

Both the audio and the audio/video groups gave significantly fewer restricted thinking responses than the control group. This was consistent with Hypotheses 11 and 12. The audio and the audio/video groups, however, did not differ significantly in this ETC at the .05 level (reject Hypothesis 10). More research is needed to explain this finding.

In the final ETC, expanded thinking questions, there were no significant differences between the audio and the audio video group, or between the audio and the traditional group. As a result, Hypotheses 13 and 15 were rejected at the .05 level. Further research is needed to explain these findings. There were significant differences between the traditional group and the audio/video group (Hypothesis 15).

In general, two patterns emerged from this study. First, the audio and audio/video groups did not differ significantly in any of the ETC's, nor did they differ in terms of the total number of interactions during the teleconferenced instruction. The question that needs to be answered is, "Can nonverbal cues that induce interaction be transmitted via television?" Perhaps the explanation lies in the way students are conditioned to watching a television screen. Viewing television is a passive activity and viewers' cognitive engagement appears to wane over time (Brown, 1988). The students in the audio/video group in this study may not have been mentally focused on the instructor when the open-ended questions were presented at the end of the lesson. As a result of this lack of attention, the audio/video teleconference experience was basically the same as the audio teleconference experience.

The second pattern that emerged was that the traditional group generally interacted more than the audio and the audio/video groups in terms of total number of interactions and in several of the ETC's. The implications of this finding on distance education are that occasional site visits on the part of the instructor may be beneficial. Further research could be conducted to determine whether site visits increase the amount of interaction that occurs during teleconferences that follow the site visits. Researchers in this study were only interested in the effects that student/instructor visual contact had on verbal interaction during teleconferences. The audio/video capabilities of the system used for the two-way audio/video teleconference would allow the user to take advantage of the attributes inherent in such a system by sharing graphics and other visual information. This may in turn stimulate verbal interaction. Further research needs to be conducted in order to determine whether effective uses of the video capabilities of teleconferencing systems influences the amount of interaction that takes place during instruction.

Finally, the assumption that the addition of visual contact is in and of itself capable of improving distance education is not substantiated in this study. In future studies, it might be beneficial to measure something other than the amount of verbal interaction that takes place during teleconferences and focus on the role of nonverbal interactions in visual delivery modes.

References

Brown, C. (1988). The live video conference in distance learning. Lifelong Learning: An Omnibus of Practice and Research, 11(5), 8-24.

Gorham, J. (1988). The relationship between verbal teacher immediacy behaviors and student learning. Communication Education, 37, 40-53.

Mehrabian, A. (1971). Silent messages. Belmont, CA: Wadsworth.

Mehrabian, A. (1972). Nonverbal communication. Chicago: Aldine-Atherton.

Ober, R., Bentley, E., & Miller, E. (1971). Systemic observation of teaching. Englewood Cliffs, NJ: Prentice-Hall.

Richmond, V., Gorham, J., & McCroskey, J. (1987). The relationship between selected immediacy behaviors and cognitive learning. In L. Barker Communication Yearbook, 10 (pp. 574-590). New Brunswick, NJ: Transaction Books.

Ritchie, H. & Newby, T. (1989). Classroom lecture/discussion vs. live televised instruction: a comparison of effects on student performance, attitude, and interaction. American Journal of Distance Education, 3(3), 36-45.

Salomon, G., & Clark, R. (1977). Reexamining the methodology of research on media and technology in education. Review of Educational Research, 47(1), 99-120.

Wagner, E., & Reddy, N. (1989). Design considerations in selecting teleconferencing for instruction. In M. Moore & G. Clark (Eds.) Readings in Distance Learning and Instruction (pp. 96-103). University Park, PA: The Pennsylvania State University.

Wiener, M., & Mehrabian, A. (1968). Language within language: immediacy, a channel in verbal communication. New York: Appleton-Century-Crofts.

Title:

Ethics Scenarios: A Critical Theory Symposium

Chair:

John C. Belland

Authors:

Jane Anderson
Suzanne K. Damarin
Denis Hlynka
J. Randall Koetting
Robert Muffoletto
Randall G. Nichols
Andrew R. J. Yeaman

Ethics Scenarios: A Critical Theory Symposium

Abstract

This session addresses the ethical position of educational communications and technology in society. Presenters create ethics scenarios and apply critical theory to provide insight. The approach is philosophical, literary and sociopolitical and reflects Derrida, Foucault and Habermas among others. This symposium is intended to stimulate questions.

Chair

Dr. John C. Belland, Ohio State University, Columbus, Ohio

Papers and Presenters

Introduction to Thinking Otherwise: Critical Theory, Ethics and Postmodernism
Dr. Andrew R. J. Yeaman, Yeaman & Associates, Denver, Colorado

Deconstruction and Educational Media
Dr. Andrew R. J. Yeaman, Yeaman & Associates, Denver, Colorado

Restructuring, Technology and Schools
Dr. Robert Muffoletto, University of Northern Iowa, Cedar Falls, Iowa

The Rite of Right or The Right of Rite:
Moving Towards an Ethics of Technological Empowerment
Dr. Jane Anderson, Ohio State University, Columbus, Ohio

Feminisms, Foucault and Felicitous Design
Dr. Suzanne K. Damarin, Ohio State University, Columbus, Ohio

Communicative Action and Educational Biotechnology
Dr. Randall G. Nichols, University of Cincinnati, Cincinnati, Ohio

Marginalizing Significant Others: The Canadian Contribution to Educational Technology
Dr. Denis Hlynka, University of Manitoba, Winnipeg, Canada

Discussant

Commentary on Postmodern Implications for the Future of Theory, Research and Development
Dr. J. Randall Koetting, University of Nevada-Reno, Reno, Nevada

Ethics Scenarios: A Critical Theory Symposium

Papers

Introduction to Thinking Otherwise: Critical Theory, Ethics and Postmodernism

Dr. Andrew R. J. Yeaman, Yeaman & Associates, Denver, Colorado

> *The imperative for many cultural agents in the era of concentration camps and nuclear weapons has been to think "otherwise," to transgress the coherent unity of a metaphysics that has proven inadequate to the problems we face.*
>
> (Ulmer, 1986, p. 27)

The purpose of this symposium is to examine the ethics of educational communications and technology. The essayists writing here reflect on ethics through contemporary critical theorists such as Derrida, Foucault and Habermas among others. The critical theory approach is philosophical, literary and sociopolitical. The emphasis is not on the ethical behavior of individuals, which seems to be the domain of the AECT Code of Ethics, but on the ethical position of educational communications and technology in society.

A secondary purpose is to encourage more scholars to engage in cultural analysis. The authors address ethical aspects of the field and provide insight by demonstrating the application of critical theory. This symposium is intended to stimulate questions about critical theory and will encourage discussion about the global effects of the field.

What is critical theory?

Critical theory dates back at least to Socrates privileging the reality of ideas or forms over the reality of appearances (Adams, 1971). Over the millennia this debate on interpretation, representation and media became the intellectual foundation of philosophy, theology, literary criticism, linguistics, psychology, communications and education. In the 1960s the literary focus of critical theory in North America was augmented through importing the European emphasis on sociological analysis and the critique of ideology (Adams & Searle, 1986).

There is no unified critical theory but critical thought[1] is nevertheless influential. Despite their disagreements, critical theorists tend to concur that reality is socially constructed, that the positivistic labeling of people is not natural and that scientific explanations of human behavior lack objectivity (Gibson, 1986). Contemporary texts produced by critical theorizing are viewed not as derivative, secondhand literature but as original, primary works actively confronting real problems (Eagleton, 1983; Hartman, 1981). Current scholarship in education takes this point of view, especially *Critical theory and education* (Gibson, 1986), *Postmodern education: Politics, culture, and social criticism* (Aronowitz & Giroux, 1991), *Postmodernism, feminism, and cultural politics* (Giroux, 1991) and *Power and criticism: Poststructural investigations in education* (Cherryholmes, 1988). Direct application to educational communications and technology is made by *Paradigms regained: The uses of illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology* (Hlynka & Belland, 1991) and *The ideology of images in educational media* (Ellsworth & Whatley, 1990).

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[1] Critical theory should not be conflated with critical thinking, the recent pedagogical movement advocating teacher centered questioning for the development of thinking skills.

This introduction also suggests these questions:
- How is criticism related to education?
- What are poststructuralism and postmodernism?
- How is critical theory related to ethics?
- What are postmodern ethics?
- How are postmodern ethics related to educational technology?

The critical theorists referenced in this symposium diverge from each other but issues of unity or fragmentation are exactly not the point. The questions applied here to the field of educational communications and technology are important to raise. The group writing in these pages seeks to develop understandings of ethical conscience as the prerequisite to any action. Whether or not the discourse of any emancipatory metanarrative is true, for critical theorists the ethical approach is necessary.

Deconstruction and Educational Media

Dr. Andrew R. J. Yeaman, Yeaman & Associates, Denver, Colorado

Derrida is part of that general movement in the humanities of our century, responding in protest to the ideological constraints of a civilization that seems bent on self-destruction.

(Ulmer, 1986, p. 27)

Deconstruction can reveal distortions and biases in education (Cherryholmes, 1988) and educational technology (Hlynka & Belland, 1991). For example, this presentation demonstrates how a safety message deconstructs into the concerns of manufacturers and dealers about product liability. It shows that doublespeak obscures the power relations of the social context (Bourdieu & Passeron, 1990):

How do things slip around so that the accidents caused by badly designed media equipment are no longer the responsibility of manufacturers, suppliers and purchasing officers but become the fault of instructors?

Reading deconstructively as a way of identifying blind spots is originally described by de Man (1983) and Derrida (1973, 1976, 1985, 1987a, 1990) and has profoundly affected literary interpretation and analytic philosophy (Rorty, 1989). Norris explains, "To 'deconstruct' a text is to draw out conflicting logics of sense and implication, with the object of showing that the text never exactly means what it says or says what it means." (1988, p. 7).

Deconstruction translates to painting (Derrida, 1987b), architecture (Norris & Benjamin, 1988; Papadakis, Cooke & Benjamin, 1990), video (Ulmer, 1989) and cinema (Brunette & Wills, 1989). Deconstruction is also useful when considering the ethics of designing, selecting and evaluating educational media.

Restructuring, Technology and Schools

Dr. Robert Muffoletto, University of Northern Iowa, Cedar Falls, Iowa

This paper inquires into the culture of schools restructuring and the role of technology (Bowers, 1988). California and Iowa function as platforms for observation and analysis. The critique will unpack the rationalizations, justifications and envisioned results from the literature of each locale.

Constructing and reconstructing schools are social political processes. American schools serve purposes reflected in the symbolic interactions, regulations, and controls over what teachers, administrators, students do and think, plus the form and content of knowledge disseminated and reproduced daily in classrooms (Apple, 1982; Apple, 1988; Apple & Weis, 1983, Gerbner, 1974, Kliebard, 1986). The conceptualization and use of various technologies became over the last 50 years a major part of schooling (Cuban, 1986; Saettler, 1990). Restructuring, and the role technology plays, can be better understood when contextualized within the historical struggles for control of American education. Within this context the unpacking of the symbolic may reveal a different agenda.

These postmodern questions (Cherryholmes, 1988) will guide the inquiry:
- What are the historical assumptions about education, technology, and the larger state agenda that guide the restructuring process?
- What will change because of the new order?
- Who makes the decisions and sets the agenda for change?
- Who may benefit from the change if it is carried out as prescribed?

The Rite of Right or The Right of Rite: Moving Towards an Ethics of Technological Empowerment

Ms. Jane Anderson, Ohio State University, Columbus, Ohio

From Freire's work in emancipatory pedagogy emerge assumptions of self-determination, collective identification, and reorientation to positions of power (1970, 1978, 1985). What do these assumptions suggest to the ethics of the liberatory researcher (Shor, 1987) involved in the promotion of educational technology? In framing a liberatory approach to educational technology, I focus on the human right and the cultural rite. Foucauldian notions on the concept of power-knowledge and the role of the "specific intellectual" will be addressed due to their affinity to these concepts.

My discussion considers:

- What might be an ethics of technological and communicative empowerment after considering Freire's emancipatory pedagogy and Foucault's notions of injustice and oppression?
- How can our field foster the creation of spaces where a multiplicity of views can co-exist and support each other?
- What approach should be taken to promote technological skills among people seeking a greater voice?

Feminisms, Foucault and Felicitous Design

Dr. Suzanne K. Damarin, Ohio State University, Columbus, Ohio

Some feminist philosophers (e.g., Noddings, 1984; 1989) and social scientists (Gilligan, 1982; Belenky, Clinchy, Goldberger & Tarule, 1986) suggest that an ethic of care should guide instructional activity and, by inference, the design of instruction. The ethic of caring is detailed by these writers in sharp contrast with the ethics of justice which undergird most discussions of ethics in relation both to technology (e.g., Ermann, Williams & Gutierrez, 1990) and to educational issues such as equity. Discussing an ethic of caring thereby introduces new (feminist) ideas into this field.

Further, the postmodern feminist critique rejects the ethic of caring as essentializing. Foucauldian analyses reveal that "caring" (like justice) promotes hierarchal observation, normalizing judgments, etc. (Foucault, 1979). These observations problematize the implications of an ethic of care and raise issues, questions and suggestions about the design of instruction.

Communicative Action and Educational Biotechnology

Dr. Randall G. Nichols, University of Cincinnati, Cincinnati, Ohio

Habermas' studies conclude that growing uses of media, and the rational-instrumental thinking that accompanies media, tends to remove humans from meaningful communication and community (1984, 1987). This growth and removal inherently involves questions of ethics. Nichols extends this argument to the educational uses of both media and extremely rational thinking (1989, 1991). Building on that foundation, this paper looks to a likely near future of educational technology (Knirk & Gustafson, 1986; Perelman, 1990) and applies Habermas' theory of communicative action. Specifically, educational biotechnology (EBT) will appear in the daily lives of all educators and learners (Heinich, Molenda & Russell, 1989, p. 403) because of the proliferation of genetic mapping and manipulation, the altering of human chemistry and public and private pressures to improve American/Western educational outcomes (Noble, 1989). The paper will suggest the use of Habermas' moral principles as guidelines for managing the ethical and educational dimensions of this near future.

Marginalizing Significant Others: The Canadian Contribution to Educational Technology

Dr. Denis Hlynka, University of Manitoba, Winnipeg, Canada

Postmodernists have developed a variety of concepts and strategies for examining contemporary society. For example, the Derridian concept of *supplementation* of the dominant discourse with minority discourses has met with significant change in practice. Black studies, feminist praxis, and ethnic discourses are only three such developments. Eco's exploration of literary texts as open and closed is reflected in slippery signifiers. *Marginalization* and *deconstruction* have resulted in an interchange of dominant and colonized. Baudrillard's precession of the simulacrum has resulted in a re-thinking of origins. Finally, Lyotard's postmodern condition has allowed us new ways of looking at the information revolution.

For several of these writers and philosophers technology is an integral component of their thinking and there are serious technological implications to be derived from a postmodern perspective. But educational technology is only beginning to examine such a perspective.

Canadian educational technology offers a clear case of postmodernism in action. Because of the peculiarities of size and population (Canada is second in geographic size next to Russia, yet with a population smaller than the state of California) and because of the Canadian proximity to an economic giant (the United States of America), Canada has long exhibited schizophrenic behavior. In many ways, to be Canadian is to be postmodern.

First, Canada as a whole is marginalized. It exists under the shadow of its neighbor. Its culture is uniquely Canadian, yet you can hardly find that culture by watching Canadian television or looking in the shelves of Canadian bookstores. Canada is a minority discourse, struggling for its own place in the world. In educational technology, Canada has unknowingly provided consistent but marginal contributions which have first deferred to the overwhelmingly American contribution, then differed from those contributions, and then finally supplemented the American discourse on educational technology. What is the Canadian discourse on educational technology? In brief it consists of the following:

- Marshall McLuhan, a postmodernist before his time, predated Derrida with his *Laws of Media* and provided the foundation for Baudrillard's exploration of the simulacrum with his famous one-liner: The medium is the message.
- The National Film Board of Canada, a unique production unit which, under the guidance of John Grierson gave meaning to the term documentary and provided a model which was adopted and then adapted by nearly all major educational film and television production organizations.
- Arthur Kroker, Canadian postmodern political scientist has examined technology and the Canadian mind by showing a continuum between despondency and freedom, and an intermixing of contributions of art and technology. The well known technologists who form the crux of Kroker's exposition are George Grant, Harold Innis and Marshall McLuhan.
- Ursula Franklin, Canadian physicist, has recently contributed to the debate by showing how the real world of technology is mediated by social, political and cultural factors which must be kept up front if one is to avoid being crushed by the inexorable rush of technology out of control.

The twenty first century is about to begin on an ambiguous and decentered note. Educational technologists know that the answer to an improved education is not merely more technology, nor faster technology, nor even more accurate technology. Educational technologists however are not Luddites who want less technology, slower technology or even no technology. Canada has made major, albeit often unrecognized and even unnoticed contributions to the dialogue exploring these relationships between technology and education. The purpose of this paper is to put that record in its proper perspective.

Discussion

Commentary on Postmodern Implications for the Future of Theory, Research and Development

Dr. J. Randall Koetting, University of Nevada-Reno, Reno, Nevada

The commentary provides an overview of the contributions and compare their positions on the ethics of the field. Observations are made about the future direction of theory and research. The commentary includes the application of theory and research to postmodern development in the field.

References and Bibliography

Adams, H. (Ed.). (1972). Critical theory since Plato. San Diego, CA: Harcourt Brace Jovanovich.

Adams, H., & Searle, L. (Eds.). (1986). Critical theory since 1965. Tallahassee, FL: Florida State University Press.

Apple, M. W. (Ed.). (1982). Cultural and economic reproduction in education: Essays on class, ideology and the state. Boston, MA: Routledge & Kegan Paul.

Apple, M. W. (1988). Teachers and texts: A political economy of class and gender relations in education. New York: Routledge.

Apple, M. W., & Weis, L. (Eds.). (1983). Ideology and practice in schooling. Philadelphia, PA: Temple University Press.

Aronowitz, S., & Giroux, H. A. (Eds.). (1991). Postmodern education: Politics, culture, and social criticism. Minneapolis, MN: University of Minnesota Press.

Ball, S. J. (Ed.). (1990.) Foucault and Education: Disciplines and knowledge. New York: Routledge.

Belenky, M.F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). Women's ways of knowing: The development of self, voice, and mind. New York: Basic Books.

Bourdieu, P., & Passeron, J. (1990). Reproduction in education, society and culture: Second edition. London: Sage Publications.

Bowers, C. A. (1988). The cultural dimensions of educational computing: Understanding the non-neutrality of technology. New York: Teachers College Press.

Brunette, P., & Wills, D. (1989). Screen/play: Derrida and film theory. Princeton, NJ: Princeton University Press.

Cherryholmes, C. H. (1988). Power and criticism: Poststructural investigations in education. New York: Teachers College Press.

Comings, J., & Kahler, D. (1987). Peace Corps literacy handbook. Washington, D.C.: Peace Corps.

Cuban, L. (1986). Teachers and machines: The classroom use of technology since 1920. New York: Teachers College Press.

de Man, P. (1983). Blindness and insight: Essays in the rhetoric of contemporary criticism: Second edition, revised. Minneapolis, MN: University of Minnesota Press.

de Man, P. (1986). The resistance to theory. Minneapolis, MN: University of Minnesota Press.

Derrida, J. (1973). Speech and phenomena and other essays on Husserl's theory of signs. Evanston, IL: Northwestern University Press.

Derrida, J. (1976). Of grammatology. Baltimore, MD: Johns Hopkins University Press.

Derrida, J. (1978). Writing and difference. Chicago: University of Chicago Press.

Derrida, J. (1982). Margins of philosophy. Chicago: University of Chicago Press.

Derrida, J. (1985). The ear of the other: Otobiography, transference, translation. Lincoln, NB: University of Nebraska Press.

Derrida, J. (1987a). The post card from Socrates to Freud and beyond. Chicago: University of Chicago Press.

Derrida, J. (1987b). The truth in painting. Chicago: University of Chicago.

Derrida, J. (1990). Limited Inc. Evanston, IL: Northwestern University Press.

DeVaney, A. (1991). A grammar of educational television. In D. Hlynka,. & J. C. Belland (Eds.). Paradigms regained: The uses of illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology: A book of readings (pp. 241-280). Englewood Cliffs, NJ: Educational Technology Publications.

Diamond, I., & Quinby, L. (1988). Feminism and Foucault. Boston, MA: Northeastern University Press.

Eagleton, T. (1983). Literary theory: An introduction. Minneapolis, MN: University of Minnesota Press.

Ellsworth, E. (1989). Educational media, ideology, and the presentation of knowledge through popular cultural forms. In H. A. Giroux & R. I. Simon (Eds.) Popular culture, schooling and everyday life (pp. 47-66). Granby, MA: Bergin & Garvey.

Ellsworth, E., & Whatley, M. H. (Eds.). (1991). The ideology of images in educational media: Hidden curriculums in the classroom. New York: Teachers College Press.

Ermann, M. D., Williams, M. B., & Gutierrez, C. (1990). Computers, ethics and society. New York: Oxford University Press.

Faigin, S. B. (1986). Basic ESL literacy from a Freireian perspective: A curriculum unit for farmwork education. (ERIC Document Reproduction Service No. ED 274196).

Foucault, M. (1977). Language, counter-memory, practice: Selected essays and interviews. Oxford, UK: Blackwell.

Foucault, M. (1979). Discipline and Punish. New York: Vintage.

Foucault, M. (1981). Power/knowledge: Selected interviews and other writings 1972-1977. Brighton, UK: Harvester Press.

Foucault, M. (1981). The history of sexuality: Volume 1: An introduction. Harmondsworth, UK: Penguin.

Frank, M. (1989). What is neostructuralism? Minneapolis, MN: University of Minnesota Press.

Freire, P. (1970). Pedagogy of the oppressed. New York: Continuum.

Freire, P. (1978). Pedagogy-in-process. New York: Seabury Press.

Freire, P. (1985). The politics of education. South Hadley, MA: Bergin & Garvey.

Gerbner, G. (1974). Teacher image in mass culture: Symbolic functions of the "hidden curriculum." In D. E. Olson (Ed.), Media and symbols: The forms of expression, communication and education: The seventy-third yearbook of the National Society for the Study of Education: Part 1 (pp. 470-497). Chicago: University of Chicago Press.

Gibson, R. (1986). Critical theory and education. London: Hodder & Stoughton.

Gilligan, C. (1982). In a different voice: Psychological theory and women's development. Cambridge, MA: Harvard University Press.

Giroux, H. A. (1983). Theory and resistance in education: A pedagogy for the opposition. New York: Bergin & Garvey.

Giroux, H. A. (1988). Teachers as intellectuals: Toward a critical pedagogy of learning. Granby, MA: Bergin & Garvey.

Giroux, H. A. (1991). Postmodernism, feminism, and cultural politics: Redrawing educational boundaries. New York: State University of New York Press.

Giroux, H. A., & Simon, R. I. (Eds.). (1989). Popular culture, schooling and everyday life. Granby, MA: Bergin & Garvey.

Habermas, J. (1984). The theory of communicative action: Volume 1: Reason and the rationalization of society. Boston, MA: Beacon Press.

Habermas, J. (1987). The theory of communicative action: Volume 2: Lifeworld and system: A critique of functionalist reason. Boston, MA: Beacon Press.

Hartman, G. H. (1981). Saving the text: Literature/Derrida/philosophy. Baltimore, MD: Johns Hopkins University Press.

Heinich, R., Molenda, M., & Russell, J. D. (1989). Instructional media and the new technologies of instruction: Third edition. New York: Macmillan.

Henricksen, B., & Morgan, T. E. (Eds.). (1990). Reorientations: Critical theories and pedagogies. Urbana, IL: University of Illinois Press.

Horkheimer, M. (1972). Critical theory: Selected essays. New York: Herder & Herder.

Hlynka, D., & Belland, J. C. (Eds.). (1991). Paradigms regained: The uses of illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology: A book of readings. Englewood Cliffs, NJ: Educational Technology Publications.

Hutcheon, L. (1989). The politics of postmodernism. New York: Routledge.

Jefferson, A., & Robey, D. (1986). Modern literary theory: A comparative introduction. Totowa, NJ: Barnes & Noble Books.

Kliebard, H. (1986). The struggle for the American curriculum, 1893-1958. London: Routledge & Kegan Paul.

Knirk, F. G., & Gustafson, K. L. (1986). Instructional technology. New York: Holt, Rinehart & Winston.

Koetting, J. R., & Januszewski, A. (1991). The notion of theory and educational technology: Foundations for understanding. Educational & Training Technology International, 28.

Leitch, V. B. (1983). Deconstructive criticism: An advanced introduction. New York: Columbia University Press.

Leitch, V. B. (1988). Taboo and critique: Literary criticism and ethics. ADE Bulletin, 90, 46-52.

Lyotard, J. (1984). The postmodern condition: A report on knowledge. Minneapolis, MN: University of Minnesota Press.

Marshall, J. D. (1990). Foucault and educational research. In S. J. Ball (Ed.), Foucault and Education. New York: Routledge.

Nelson, C. (Ed.). (1986). Theory in the classroom. Urbana, IL: University of Illinois Press.

Nichols, R. G. (1989). Reconciling educational technology with the lifeworld: A study of Habermas' theory of communicative action. Proceedings of selected research paper presentations at the 1989 Annual Convention of the Association for Educational Communications and Technology, 341-355. (ERIC Document Reproduction Service No. ED 308805).

Nichols, R. G. (1991). Toward a conscience: Negative aspects of educational technology. In D. Hlynka & J. C. Belland (Eds.). Paradigms regained: The uses of illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology: A book of readings (pp. 121-137). Englewood Cliffs, NJ: Educational Technology Publications.

Nicholson, L. (1989). Feminism/postmodernism. New York: Routledge.

Noble, D. D. (1989). Mental materiel: The militarization of learning and intelligence in US education. In L. Levidow & K. Robins (Eds.), Cyborg worlds: The military information society (pp. 13-41). London: Free Association Books.

Noddings, N. (1984). Caring: A feminine approach to ethics and moral education. Berkeley, CA: University of California Press.

Noddings, N. (1989). Women and evil. Berkeley, CA: University of California Press.

Norris, C. (1982). Deconstruction: Theory and practice. London: Methuen.

Norris, C. (1989). Deconstruction and the interests of theory. Norman, OK: University of Oklahoma Press.

Norris, C., & Benjamin, A. (1988). What is deconstruction? New York: St. Martin's Press.

Ohmann, R. (1985) Literacy, technology, and monopoly capital. College English, 47 (70), 675-689.

Papadakis, A., Cooke, C., & Benjamin, A. (1990). Deconstruction. New York: Rizzoli.

Poster, M. (1989). Critical theory and poststructuralism. Ithaca: Cornell University Press.

Poster, M. (1990). The mode of information: Poststructuralism and social context. Chicago: University of Chicago Press.

Rabinow, P. (1986). Representations are social facts: Modernity and post-modernity in anthropology. In J. Clifford & G. E. Marcus (Eds.), Writing culture: The poetics and politics of ethnography (pp. 234-261). Berkeley, CA: University of California Press.

Rorty, R. (1989). Contingency, irony, and solidarity. Cambridge, UK: Cambridge University Press.

Saettler, P. (1990). The evolution of American educational technology. Englewood, CO: Libraries Unlimited.

Sarup, M. (1989). An introductory guide to post-structuralism and postmodernism. Athens, GA: University of Georgia Press.

Shor, I. (Ed.) (1987). Freire for the classroom: Sourcebook for liberatory teaching. Portsmouth, NH: Boynton/Cook.

Siebers, T. (1986). The ethics of criticism. Ithaca, NY: Cornell University.

Squires, N. (1990). A Freireian-inspired video curriculum for at-risk high school students. English Journal, 79 (2), 49-56.

Taylor, W. D., & Johnsen, J. B. (1986). Resisting technological momentum. In J. A. Culbertson & L. L. Cunningham (Eds.), Microcomputers in education: Eighty-fifth year book of the National Society for the Study of Education (pp. 216-233). Chicago, IL: University of Chicago Press.

Ulmer, G. L. (1985). Applied grammatology: Post(e) pedagogy from Jacques Derrida to Joseph Beuys. Baltimore, MD: Johns Hopkins University Press.

Ulmer, G. (1986). Sounding the unconscious. In J. P. Leavey, Jr. (Ed.), GLASsary (pp. 23-139). Lincoln, NE: University of Nebraska Press.

Ulmer, G. (1989). Teletheory: Grammatology in the age of video. New York: Routledge.

Wells, S. (1986). Jürgen Habermas, communicative competence, and the teaching of technical discourse. In C. Nelson (Ed.). Theory in the classroom (pp. 245-269). Urbana, IL: University of Illinois Press.

Willis, G. H. (1975). Curriculum criticism and literary criticism. Journal of Curriculum Studies, 7, 3-17.

Young, R. E. (1990). A critical theory of education: Habermas and our children's future. New York: Teachers College Press.

Title:

The Effects of Two Instructional Conditions on Learners' Computer Anxiety and Confidence

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The Effects of Two Instructional Conditions on Learners' Computer Anxiety and Confidence.

In spite of the diffusion of computers into our society, there remains a large number of people who continue to suffer from computer anxiety. Zelman (1986) reported the results of a 1985 survey of over 2 million school teachers by the Corporation of Public Broadcasting in which 31% of the respondents felt uncomfortable using computers and 13% reported avoiding computers. Computer anxiety appears to be a problem for a large number of people.

Computer anxiety is generally viewed as a form of state anxiety associated with computer use (Howard, 1984; Cambre & Cook, 1985) and is usually defined in a manner such as "the fear or apprehension felt by individuals when they used computers, or when they considered the possibility of computer utilization" (Simonson, Mauer, Torardi, & Whitaker, 1987, p. 238). This fear or apprehension is generally believed to cause debilitating thoughts. These thoughts negatively affect learning by interfering with the processing and encoding of information during instruction.

As our society becomes more dependent upon retrieval of information, computer technology permeates our organizational structures. Nearly half of all white-collar workers are using computers in their daily work (Howard, Murphy, & Thomas, 1987). Sanders and Stone (1986) report that the U. S. Department of Labor estimates that for this next generation as much as 75% of all jobs will involve the use of computers. This importance of computer-related skills for future career requirements, makes the issue of computer anxiety a contemporary issue in education. Because of the size and the importance of this problem, we need to analyze the results of research on computer anxiety so that we can more seriously address learners suffering from the debilitating effects of computer anxiety.

Most of the literature on computer anxiety involves case studies. These articles relate experiences involving teaching of workshops or courses with computers and reflections of the authors perceptions about what works or does not work. While these articles may be helpful to those designing and delivering computer instruction, they contribute very little to the development of a research base in computer anxiety.

Howard, Murphy, and Thomas (1987) state that future research needs to examine the types of instructional strategies that are most effective in reducing computer anxiety. Tobias (1979) suggests that it is important to investigate the aptitude-treatment-interactions in areas of anxiety, in order that we can better fit anxiety reduction strategies to the individual characteristics of learners.

Purpose of the Study

Because the literature is lacking research that investigates the influence of specific instructional strategies on the reduction of computer anxiety for learners, this need should be addressed. In view of the importance of computer anxiety and attitudes toward computers to the instruction and training of learners, the purpose of this study, therefore, was to investigate the relationship of computer anxiety reduction to instructional strategies and learner characteristics.

Specifically, this study sought answers to the following broad questions:

1. What type of instructional intervention contributes to reduced computer anxiety?
2. What learner characteristics interact with the types of instructional interventions that reduce computer anxiety?
3. What is the nature of the learners' perceptions that occur during instructional reduction of computer anxiety?

Anxiety

In spite of a trend toward increased research in the area of human anxiety, anxiety as a construct has still resisted a consensus of its definition and measurement (Cambre &

Cook, 1985). There is, however, a commonality to most definitions of anxiety---"a fear about something in the future" (Howard & Smith, 1986). Cattell & Scheier (1958) using factor analytic studies developed the concepts of two types of anxiety. The first, called trait anxiety, is a generalized anxiety or a global, basic, and permanent tendency to be anxious. The second, state anxiety, is a situation specific, fluctuating, and transitory tendency to become anxious.

Eysenck (1979) and Tobias (1979) have suggested that anxiety is particularly debilitating to learning when the task is difficult and when there is a strong need for memory in performance of the task. It is, therefore, important to intervene and facilitate the reduction of anxiety when its effects are impairing.

Tobias (1979) proposed a model for the effect of anxiety on learning from instruction. This model suggested that anxiety interferes most with learning before, and during input by the learner. Before processing, anxiety acts as a diversion to attention. During processing, anxiety directly interferes with the cognitive processing and storage of information by the learner. Postprocessing anxiety obstructs later retrieval of content mastered during instruction. Based on this model, Tobias made recommendations regarding instruction which is expected to reduce the effects of anxiety on learning. He suggested that instruction for anxious learners should allow learners to repeat content and reduce the extent to which learners must rely on memory.

M. W. Eysenck (1984) stated that actual performance for high anxiety individuals and low anxiety individuals is less clear than the anxiety differences. He stated that experimental evidence suggests that high anxiety learners compensate for decreased cognitive capacities (due to anxiety related task- irrelevant cognitive activities) by increasing effort on the task. Anxiety level, itself, is not the determining factor on behavior and choice. It is necessary, therefore, to look at the interaction of anxiety stimuli and specific characteristics of the learners, which might help predict or interpret their behaviors under conditions of anxiety.

Activation Theory

Activation Theory (Berlyne, 1960; Fiske & Maddi, 1961; Malmo, 1971) as it applies to anxiety has typically involved three concepts: impact, activation, and arousal. Impact can be thought to be the momentary contribution of a stimulus to the reticular arousal system (RAS), a network of nerve cells that extends through the lower brain. Activation is the degree of physiological excitation in the RAS. Activation level is related to the intensity of the impact, but can vary due to the influence of changes in the somatic, or physical, state of the individual. Arousal is the actual manifestation of the activation in the individual, such as the emotions of anxiety or anger. Arousal, in turn, affects activation through feedback, by changing the impact of other stimuli.

The relationship of performance to activation and arousal (Fiske & Maddi, 1961; Malmo, 1971) has been summarized in three statements: (a) there is an optimal level of arousal for best performance; (b) above or below this optimal level, performance is relatively impaired; and (c) performance impairment increases with the distance from the optimal level. Studies (Hines & Mehrabian, 1979; Mehrabian & West, 1977; Russell & Mehrabian, 1975) have shown a detrimental effect of relatively high levels of arousal on performance and attitude in work situations. Russell and Mehrabian (1975) also found that in unpleasant situations, avoidance behavior is a direct correlate to arousal state. The optimal level of arousal varies from individual to individual.

Arousal-Seeking Tendency

Each individual has an optimal level of arousal, not only for performance, but also for emotional comfort. A person's preferred arousal level (Mehrabian & Russell, 1974) is closely related to his or her preference for an environment. The avoidance or attraction of individuals for a stimuli, such as a computer, is related to not only their level of arousal, such as anxiety, but also to their preferred level of arousal. Mehrabian and

Russell (1974) have isolated a homogenous trait they call "arousal-seeking tendency" which is a measure of that level of arousal that individuals find most comfortable. The arousal-seeking tendency was defined as the extent of the level of arousal that an individual finds most comfortable.

Mehrabian & Russell (1974) developed the Arousal-Seeking Tendency Scale (ASTS). They administered the ASTS and other inventories to 530 subjects. Results showed that ASTS scores were significantly correlated to state anxiety, trait anxiety, and extrovertism. Mehrabian (1977), using 325 college undergraduates, found other significant correlates to the ASTS. Sensitivity to rejection was negatively and moderately correlated to ASTS scores. Achieving tendency, extrovertism, and dominance were moderately positively correlated to ASTS scores.

Mehrabian (1978), in a later study of 118 undergraduates, investigated individual reactions to positive and negative situations. Results showed that high arousal seekers showed a significantly greater approach tendency for preferred environments than low arousal seekers. This pattern was also significant for positive work environments. Arousal-seeking tendency is associated with an individual's response to stimuli, i.e. anxiety level. Anxiety, as an emotion, would only be expected to be detrimental when the level of arousal is much higher or much lower than the learner's preferred arousal level. When looking at anxiety levels and changes in those levels, it is probably important to consider the learner's arousal seeking tendency. Arousal-seeking tendency was, therefore, included as a variable in this study.

Anxiety Coping Style

How the learner deals with anxiety stimuli are also important factors relating to the influence of instructional interventions. Tucker (1986) stated that regulatory biases affect the activation and arousal systems, and that "the most adaptively significant is the bias toward internal versus external determination of the information flow" (p. 293). This bias is probably associated with clearly discernable personality traits (Tucker & Williamson, 1984). Some learners, when at high anxiety levels, seek external stimuli as their preferred source of information. Other learners adapt to high anxiety levels by focusing attention inward, thus ignoring outside stimuli and information. These internally adaptive individuals, while reducing anxiety levels, would probably not undergo cognitive changes in relation to computer skills and attitudes, when experiencing computer anxiety during instruction.

Miller (1987) has suggested such a personality trait. She proposed two styles for coping during stressful events: monitors (externally oriented, information seekers) and blunters (internally oriented, distractors). For example, under the anxiety of an impending surgical procedure, a monitor would want to know as much as possible about the procedure to better deal with the stress. A blunter, on the other hand, would prefer to be told as little as possible--ignorance is bliss. Coping style was defined as the degree to which individuals monitor versus blunt stimuli from their environment when experiencing anxiety. Miller asserts that the degree of monitoring and blunting can be measured using the Miller Behavioral Style Scale (MBSS).

Several studies have looked at coping style and its relationship to arousal and arousal-seeking tendencies. Sparks and Spirek (1988) reported two studies aimed at investigating differences between high monitoring subjects and high blunting subjects. Results showed a significant main effect for coping style, with monitors having higher anxiety levels than blunters. Results showed that coping style was significantly related to anxiety levels and preferred behaviors toward stress.

Hines and Mehrabian (1979) found that monitors and blunters differed significantly in avoidance of unpleasant settings. Monitors in the 325 undergraduate sample showed more avoidance responses to unpleasant stimuli than did blunters.

The importance of coping style to instruction and anxiety is that under stressful computer anxiety in an instructional setting, blunters would be expected to prevent assimilation of instruction and potential anxiety reducing interventions by blocking or distracting external stimuli (such as instructional information). Coping style can have an influence on changes in computer anxiety levels, and was, therefore, included as a variable in this study.

Locus of Control

A major cause of computer anxiety has been suggested to be associated with a feeling that one has lost control of outcomes when interacting with a computer (Bloom, 1985; Honeyman & White, 1987; Meier, 1985). The focus of most research done on perceptions of personal control has involved the concept of locus of control, developed out of social learning theory (Rotter, 1954; Rotter, Chance, & Phares, 1972). The concept of locus of control emerged due to systematic differences in expectancies following reinforcement (Rotter, 1975). Locus of control (Rotter, 1966) is a term used to describe a generalized expectancy for internal versus external control of reinforcements. Belief in internal control is a result of a perception that events are contingent upon ones behavior. Perceptions of external control are views that reinforcements are the result of such factors as luck, chance, or fate. Locus of control does not refer to the actual extent of control the individual has in a situation, rather it refers to the individuals perception of control (Rotter, 1975).

The generalizability of locus of control is important. Rotter (1975) emphasized that specific experiences in a particular situation, not only determine expectancies for that situation, but also for other situations. He theorized that in more novel or ambiguous situations (as long as it is not perceived to be random) the learners rely on their generalized expectancy. This is because they have no specific expectancy in a situation that is new to them. Phares (1976) reported that personality characteristics have been found to be generally associated with external locus of control individuals. Among these is a high level of succorance, a need for assistance under conditions of distress. Externals would, therefore, function better in anxious situations when help or assistance is available.

Because computer experiences are relatively novel for beginners, locus of control has been investigated as a potential correlate to computer anxiety. Studies (Howard, Murphy, & Thomas, 1987; Morrow, Prell, & McElroy, 1986) have found a significant relationship between locus of control and computer anxiety in college students. Lazarus (1966) proposed that individuals with internal locus of control beliefs are better equipped psychologically to handle perceived threats and are, therefore, less likely to be anxious in a threatening situation. Locus of control was, therefore, investigated as a variable in this study.

Sex Differences

There are several differences between male students and female students that would be expected to impact the influence of instruction on computer anxiety. Wolleat, Pedro, Becker, and Fennema (1980) administered the Mathematics Attribution Scale (MAS) to 1224 secondary students enrolled in college preparatory mathematics classes. Females exhibited significantly more of the learned helplessness (external locus for success and internal locus for failure) in their responses, even after achievement level was separated out. These types of differences, although potential factors, are not identifiable with measures of locus of control.

Mehrabian (1977) found significant sex differences in coping styles, with females more likely to monitor under stress. His results also showed that these monitoring coping styles increased avoidance responses in unpleasant situations. It would be expected that females would, therefore, be more avoidant of computers when experiencing similar levels of anxiety as males. Males, on the other hand, would be more likely to blunt instruction and intervention under high levels of computer anxiety.

Studies (Cambre & Cook, 1987; Raub, 1981; Rohner & Simonson, 1981; Rosen, Sears, &

Weil, 1987), have also found significant correlations of computer anxiety levels to the learner's sex. These studies have shown females to possess higher levels of computer anxiety.

The interaction effects of the sex of the learner with other variables can be quite complex. It can, however, be used to make certain predictions of behavior. The learner's sex was, therefore, included as a variable in this study.

Computer Anxiety

Computer anxiety can be viewed as a form of state anxiety associated with computer use (Cambre & Cook, 1985; Howard & Smith, 1986). Computer anxiety was defined as "the fear or apprehension felt by individuals when they used computers, or when they considered the possibility of computer utilization" (Simonson, et al., 1987, p. 238). Researchers (Cambell, 1986; Simonson, et al., 1987) have used state-anxiety instruments to validate computer anxiety scales.

Because state anxiety is transitory in nature, its levels can be changed by interventions. Thus, anxiety reducing strategies can be expected to achieve changes in computer anxiety. Studies (Cambre & Cook, 1987; Howard, Murphy, & Thomas, 1987; Raub, 1981) have, in fact, shown that instruction can reduce computer anxiety in most learners.

While research about students' attitudes toward computers was performed as early as 1965 (Mathis, Smith, & Hansen, 1970), the study of computer anxiety as a construct was begun by Powers, Cummings, and Talbott in 1973 (Cambre & Cook, 1985). Much of the literature on computer anxiety involves case studies (Howard & Kernan, 1989). Other studies (Cambre & Cook, 1987; Howard & Smith, 1986; Loyd & Gressard, 1984; Raub, 1981; Simonson, et al., 1987) have looked at correlations between computer anxiety and learner characteristics, and the overall influence of computer instruction on computer anxiety scores. There is very limited data regarding the effect of specific instructional methods on computer anxiety. None of these studies had, in fact, investigated the relationship of specific instructional strategies or interventions to computer anxiety.

Researchers (Banks & Havice, 1989; Bloom, 1985; Winkle & Mathews, 1982) stated the importance of using instructional strategies to reduce anxiety-related fears toward computers. Very few studies, however, have actually investigated the effect of instruction on individuals' computer anxiety. Cambre and Cook (1987) investigated factors related to computer anxiety and overall changes in computer anxiety scores over a five-day (10 hour) instructional workshop. The subjects (*N*=865 pretreatment; *N*=770 posttreatment), who signed up for an open introductory computer workshop, ranged in age from 9 to 75 years. Computer anxiety was measured by response to one embedded item "I am afraid to use computers." Precourse computer anxiety was significantly related to sex, but not age. Postcourse computer anxiety was significantly related to age, but not sex. Due to complete anonymity of the subjects, individual changes in computer anxiety could not be examined. The overall reported computer anxiety levels were, however, dramatically reduced.

Honeyman and White (1987) examined the effect of instruction on computer anxiety based upon the level of previous computer experience. The subjects (*N*=38) were students enrolled in an introductory computer course for teachers and administrators. The treatment involved 60 hours of instruction on the use of application software, with approximately 80% of the instructional time working on the computers (two persons per computer). The STAI was used to measure the level of anxiety with computers prior to instruction, at the midpoint of instruction, and the penultimate instructional session. Sex, age and occupation were not significantly related to anxiety scores. Previous level of experience was only related to beginning state anxiety. Overall state anxiety scores and last half anxiety scores were significantly improved during the instruction.

Howard (1986) then used a pre-post study on 39 managers enrolled in EMBA classes to investigate the effect of a microcomputer training session on computer anxiety and attitudes. Subjects were randomly assigned into the treatment and control groups. The treatment group received one and one-half hours of instruction and hands-on practice with Lotus 1-2-3 and use of DOS commands, while the control group received a lecture on BASIC programming over the same amount of time. While the treatment group had marginal reduction of computer anxiety, the control group had substantially raised level of computer anxiety. Results also showed no significant differences in treatment effect between the high anxiety subjects and low anxiety subjects.

Howard, Murphy, and Thomas (1987) looked at the effect of instructional sequence of BASIC (an unfriendly programming language) and VISICALC (a more user-friendly program) on computer anxiety and the relationship between computer anxiety and learner characteristics. One treatment group was taught BASIC before VISICALC, while the other group was exposed to VISICALC first. The 44 subjects were nonrandomly assigned into treatment groups. While computer anxiety scores were reduced over the five-week introductory computer course in the college of business, there were no significant differences between the two treatment groups. They used the same instruments as Howard's (1986) previous studies. Pretest computer anxiety was found to be significantly correlated (p=.05) to locus of control, math anxiety, trait anxiety, computer knowledge, computer experience, and class rank.

Because computer anxiety is a perception of threat or a fear relating to computer interaction, early strategies which are aimed at improving confidence would be expected to act as a positive intervention technique. Such confidence-building strategies in computer instruction would be expected to decrease fear of failure with computers---a factor in computer anxiety (Johanson, 1985; Rosen, Sears, & Weil, 1987). Cattell and Scheier (1958) concluded from an analysis of 13 studies investigating over 800 variables relating to anxiety, concluded that anxiety does, indeed, appear as a lack of confidence. Computer confidence in this study will be defined as the degree of positive expectancy of ones abilities and efficacy felt by individuals when they used computers, or when they considered the possibility of computer utilization.

M. W. Eysenck (1979) and Tobias (1979) stated that anxiety interferes with attention to task, and processing and encoding of information. Based upon this information-processing model, they recommend that instruction for anxious learners should allow learners to repeat content and reduce reliance on memory. Hands-on practice or experience during the instruction would also be expected to help maintain the learners' attention to the instructional task.

Bloom (1985) stated that through practice, learners who experience success build their confidence levels. Keller (1983), Keller and Kopp (1987), and Keller and Suzuki (1988), as part of an instructional design model for motivating learners, identified learner practice of new knowledge in a supportive atmosphere, such as with the instructor available, as motivating for students. Practice as a component of learner performance after demonstration of a skill is an element of Gagne's (1977) events of instruction. Practice is "one of the most powerful components in the learning process" (Dick & Carey, 1985, p. 138).

The practice, however, may be most helpful if it immediately follows the demonstration of the skill during instruction. Widmer and Parker (1983) prescribed the use of immediate hands-on practice for computer learners in order to reduce computer anxiety. Ernest and Lightfoot (1986) and Lewis (1988) also suggested that computer anxiety can be reduced if the instructor's demonstration of computer skills be immediately followed by learners' hands-on practice.

Giving learners opportunities for hands-on experience and practice of recently learned computer skills during instruction allows for the recommended repetition and improved information storage. Furthermore, as the learners successfully master computer skills, with the help of these strategies, their expectancy for success increases. This improvement in confidence level can be expected to reduce feelings of fear-related anxiety.

The literature supports the use of instructional interventions to reduce anxiety and fears related to computers during learning. Opportunities to practice computer skills, immediately after demonstration and during the instructional process is believed to be an important strategy for the reduction of computer anxiety. The treatments this study, therefore, investigated were the use of hands- on computer experience and practice as part of the instructional process and absence of computer practice during instruction. Because the learner's mastery of computer skills and confidence toward computers are believed to be linked to computer anxiety reduction, they were also investigated as variables in this study.

Methods

This study used multiple repeated measures in a 2 x 2 x 2 quasiexperimental design with in-class hands-on computer experience and practice during instruction, arousal-seeking tendency, coping style, sex, computer skill mastery, and locus of control as the independent variables. Each of the independent variables had two levels: (a) in-class hands-on computer experience and practice during instruction (hands-on computer experience or no hands-on computer experience), (b) sex (male and female), (c) arousal-seeking tendency (high and low arousal seeking), (d) coping style (high and low monitoring), and (e) locus of control (high and low externality). The dependent variables for this study, pre and post computer anxiety and computer confidence scores, were discrete variables.

Subjects

The subjects were 120 students (61 male, 58 female, and one non-report) enrolled in an undergraduate level introductory computer course at a large midwestern university. This course is a computer literacy and survey course with computer mastery emphasis in the use of electronic spreadsheets. Although this is a required course in the College of Business, many students with other majors enroll in this course. They averaged 20.7 years of age, however 68% were either 19 or 20 years of age at the beginning of the study. A majority of the subjects were, therefore, what might be termed traditional freshmen and sophomores.

The subjects had self-selected into the specific laboratory and lecture sections. Random assignment of subjects into treatment groups was not practical in this type of study in a natural setting. However, it was believed that assignment into sections, to some extent performed by computer because of the high demand for this offering, should provide fairly similar treatment groups.

The subjects had very little previous experience in the content to be taught during the treatments. At the beginning of the study, 61% of the subjects reported having no previous computer spreadsheet experience, and 86% reported using computers with spreadsheets or databases less than ten times.

Procedures

The two graduate assistants who volunteered to participate each had one of their two sections randomly assigned to one of the two treatment levels, the other section was then assigned into the other treatment. Because the laboratory sections of this course are traditionally taught in a lecture style with demonstration of computer skills by the instructors without the students at computers, the sections that were assigned to the no hands-on treatment were run in the usual manner, without hands-on computer experience and practice during the instruction. The section assigned to in-class hands-on computer experience during instruction, met in a different location for the eight week treatment period of the study, a computer lab in another building on campus that was approximately one-half mile away.

The subjects were given the pretests during the first lecture session of the second week of the semester, at which point the enrollments had become relatively stable. Due to time limits and constraints by the coordinator of the course, the pretest instruments were administered in the lecture class at a point when all of the treatment laboratory sections had met once. After the eight-weeks of instructional treatment, the subjects were then given the posttest instruments during the laboratory class (where the attendance rate was higher) to decrease the attrition rate. The resulting data were analyzed based upon the research questions.

Three subjects in each treatment section/class (a total of twelve subjects) were randomly selected and asked to complete a journal of their thoughts and feelings during the period of the treatment. Seven subjects (five males and two females) declined participation and other randomly selected subjects were asked to volunteer until the twelve volunteers were obtained.

The journals were collected from the subjects at the end of the eight week treatment period. Two subjects, one from each of the hands-on treatment sections, did not return their journals were eliminated from the analysis. The ten returned journals were coded and analyzed for the subjects' cognitive and affective perceptions of the computer instruction using content analysis techniques and qualitative matrix analyses to identify trends in responses.

Instructional Treatments

Instruction was primarily similar in the two treatments, except for the opportunity for students to have in-class hands-on computer experience and practice of skills during portions of the instruction. This contrasted with the other treatment, the traditional instruction for these classes, which consisted of the instructors demonstrating the computer skills and then repeating the demonstrations or answering students' questions. In both treatments the instructors demonstrated the computer skills using a personal computer, a liquid crystal display panel, and overhead projector. The traditional course structure only gave hands-on experience outside of class while the students were basically on their own, the laboratory room aides typically only helped with hardware problems. Both treatments included the same types of assignments, requiring outside hands-on computer experience in the laboratory room or some other computer environment. In each group students, on the average, waited three to four days to work on the computer outside of class.

The content covered during the treatment period -- handling of floppy discs, basic DOS commands, and spreadsheet operations -- was the same, and time on task was approximately equal in the two treatments. Specifically, the instructional treatment was composed of eight scheduled 50 minute laboratory sections, one per week. Students were first oriented to the computer, use of the keyboard, handling of diskettes, and basic DOS commands. Then instruction in the use of VP Planner, an electronic spreadsheet application program, was given during the last six-weeks of the treatment period. Spreadsheet skills taught during the treatment ranged from relatively simple operations such as using menus, saving, and loading files to more complex concepts such as the use of mixed cell addresses, formulas, and functions.

On the average, the instructor would spend the first 15 minutes of the class to occasionally take attendance, collect assignments, return graded work, administer short quizzes, and set up the demonstration computer, projector, and software. Of the remaining 280 minutes of instructional time-on-task in the lab classes during the hands-on treatment, approximately 200 - 220 minutes of time was spent by the students getting hands-on computer experience during the classroom instruction. Because the completion of laboratory assignments required computer work outside of class in the general computer laboratory room, all students in both treatments working on assignments received hands-on computer experience to some extent beyond the manipulated instructional treatments.

The two laboratory assignments during the treatment period involved the creation of spreadsheets using formulas or functions to calculate data, a budgetary spreadsheet (calculating monthly income and expenses for a fictional company) and a financial spreadsheet (calculating monthly payment amounts for various loan amounts at a number of different interest rates). Two laboratory quizzes were also administered during the treatment period and contributed toward the subjects laboratory grade. The first quiz covered basic information about floppy diskettes and simple spreadsheet terms. The second quiz was over spreadsheet formulas, operations, and more advanced terms.

The eight-week treatment period was used in the design of this study for reasons of ethics. This design allowed learners in both treatment groups to have approximately half of the course with the same traditional instructional techniques. Hands-on computer experience and practice during instruction was not expected to have detrimental effects on learners. If, however, the hands-on computer experience and practice during instruction had a positive effect, as expected, on the subjects over the course of the study, then this design diminished any disadvantage the other treatment group or those not participating in the study (but still being graded with those in the practice group) may have experienced over the total period of the course. Limited availability of the computer facility did not allow the other sections to have later access to the hands-on treatment as an alternative to the design.

Instructors

One faculty member, the coordinator of the course, taught the two large lecture classes for all twelve sections of this offering. Six graduate assistants each taught two of the laboratory sections, which met once a week for a 50 minute session. Two of the six graduate assistants volunteered to participate in the study. Two graduate assistants expressed an interest in participating, but declined due to scheduled back-to-back classes. It was not practical to teach consecutive classes ten minutes apart in two different areas of the campus. The other two instructors declined participation in the study without explanation for their decision.

Both lab instructors participating in the study had previous experience in teaching the laboratory section of the course and were Master's Degree level Graduate Assistants. They both stated prior to the study, that they thought the hands-on treatment would be better for the students, and therefore were happy to participate in the study. The instructors did not have the same teaching style, one was more serious but was better organized and more helping to the students. Both instructors were fairly consistent in style across the treatments. The instructors did not have previous experience in teaching this course with students' hands-on computer experience during the instruction. While one of the instructors adapted quickly to the new teaching environment, the other had some difficulty keeping the entire class on task when helping individual students to solve problems during the instruction. After the third week, the researcher suggested some teaching strategies to that instructor in order to improve the quality of hands-on time for the subjects, and immediate improvements were made.

Instrumentation

Subjects were given a packet containing a battery of instruments for the pretest during their first lecture meeting of the second week of classes in the spring semester. Administration of the pretest to the 250 students in each lecture section required approximately 35 minutes. These tests have been selected as measures of the variables investigated in this study. At the end of the eight-week study, a posttest was administered to the subjects in the treatment laboratory sections. Administration of the posttests to the approximately 40 subjects in each laboratory section required approximately 15 minutes.

Computer Anxiety. Computer anxiety, defined as the fear or apprehension felt by individuals when they used computers, or when they considered the possibility of computer utilization, was measured with the Computer Anxiety Subscale of the Computer Attitude Scale (CAS) (Gressard & Loyd, 1984). This scale contains ten items and uses a four-level Likert-type response scheme. Loyd and Gressard (1984) report this subscale of the instrument to have a coefficient alpha reliability of .86. The instrument was validated by judges ratings and an factor analysis of the ratings of 155 subjects. Computer anxiety scores may range from 10 to 40. High scores represent high levels of computer anxiety. The computer anxiety score was measured by summing the decoded responses to the items in the Computer Anxiety Subscale.

Computer Confidence. Computer confidence, defined as the degree of positive expectancy of ones abilities and efficacy felt by individuals when they used computers, or when they considered the possibility of computer utilization, was measured with the Computer Confidence Subscale (CCS) of the CAS (Loyd & Gressard, 1984a). This scale is comprised of 10 four-level Likert-type items. The CCS has a .95 alpha reliability coefficient. Validity was shown through a .73 correlation to computer anxiety scores and a factor analysis which showed loadings for the computer confidence items in a separate factor from the computer anxiety and liking items. The computer confidence score was measured by summing the decoded responses to the Computer Confidence Subscale. CCS scores may range from 10 to 40. High scores represent high levels of computer confidence.

Coping Style. Coping style, defined as the degree to which individuals monitor versus blunt stimuli from their environment when experiencing anxiety, was measured with the Miller Behavioral Style Scale (MBSS). The MBSS consists of four hypothetical stress situations, each of which is followed by four monitoring strategies and four blunting strategies. Subjects selected those strategies they would be likely to use. Miller (1987) reports the MBSS test-retest reliability over a 4-month period for this scale, r = .75, and scores have been found to be unrelated to sex, race, and age. The MBSS was validated experimentally, with blunting scores having a strong negative correlation (-.79) to observed monitoring behavior and the alpha coefficient for the blunting scale = .68 (Miller, 1987). Total score was derived by subtracting the number of blunting strategies selected from the number of monitoring strategies chosen. Scores may range from +16 to -16, and positive scores represent monitors and negative scores identify blunters.

Arousal-Seeking Tendency. The arousal-seeking tendency, defined as the extent of the level of arousal that an individual finds most comfortable, was assessed with the Measure of Arousal-Seeking Tendency (MAT) (Mehrabian & Russell, 1974). This 40-item instrument uses a nine level Likert-type format. The MAT has a four to seven week test-retest reliability of .88, and a Kuder-Richardson reliability coefficient = .87 (Mehrabian & Russell, 1974). Scores were measured by summing the coded responses to all forty items. Arousal-seeking tendency scores on this scale range form -160 to +160. High scores on this scale represented high arousal seeking-tendency.

Locus of Control. Rotter's (1966) 29-item Internal-External Control Scale (IECS) was used to measure the extent to which each subject holds generalized external control beliefs versus internal control beliefs. Using six filler items to disguise the purpose of the test, 23 internality-externality items are used to determine each subjects degree of externality. Scores may range from zero to 23. High scores on this scale represented a more external orientation. These generalized beliefs are most closely associated for an individual in a novel situation. The IECS has reported internal reliability estimates from .65 to .79 (Harrow & Ferrante, 1969). Test-retest reliabilities over a six-week period have been reported as .75 (Phares, 1976). The items in the scale were validated against ratings on subjects by physicians and nurses (Rotter, 1966).

Computer Experience. The amount of various types of computer experience by the subjects before and after treatment was assessed by questions regarding previous wordprocessing, programming, spreadsheet, database, and recreational use. Responses were assigned numerical values from 0 to 5 for each of the four questions, with high scores representing more computer experience in each of the four categories.

Computer Skill Mastery Level. The degree of computer skill mastery was measured by using the average of the grades obtained for computer laboratory class during the eight-week treatment period. The four grades during the treatment period were based on two in-class quizzes and two out-of-class assignments involving applications of spreadsheet skills taught during the laboratory class. High grades represented high computer skill mastery levels and were assigned by intervals corresponding to ranges of five percentage points.

Data Analysis

Descriptive statistics for this study include means for each treatment group in the measures of computer skill mastery level, MBSS, MAT, IECS, pre and post Computer Anxiety, pre and post CCS, scores. The number of male and female subjects and subjects' ages are reported for the total sample and for each treatment group. Means for each type of computer experience for both treatment groups before and after treatment are also reported. The mean response measures of the perceived interest, relevance, and satisfaction levels of the treatment laboratory classes, attendance rates, and time lag after class until working on computers are reported.

In order to address the research questions, analyses used two-way analysis of variance (Time X Treatment) on one repeated factor (Pre- and Post- Computer Anxiety; and Pre- and Post- Computer Confidence), three-way analysis of variance (Time X Treatment X Locus of Control, Sex, Coping Style, and Arousal-Seeking Tendency) on one repeated factor (Pre- and Post- Computer Anxiety), and partial correlations for the combined treatments on variables (Computer Skill Mastery Level to Computer Anxiety; and Computer Skill Mastery Level to Computer Confidence). Alpha for these statistical tests was set at 0.05.

The subjects' entries into the journals were coded using content analysis techniques and analyzed using qualitative matrix analysis techniques (Miles & Huberman, 1984). The horizontal categories in the matrix were consecutive two- week time periods during the study. The vertical categories were identified through a content analysis of the subjects' journal entries, including both positive and negative perceptions of the subjects.

Data

One hundred forty-seven subjects participated in the study. Twenty-seven subjects were eliminated from data analysis, due to attrition and excessive missing or out-of-range responses. The in-class hands-on computer experience during instruction treatment group contained 51 subjects and the no hands-on computer experience during instruction treatment contained 69 subjects. Sixty-one percent of the total subjects, and 61% in each treatment group reported they had never used a computer spreadsheet or database before the study.

Table 1
Comparisons of Mean Scores for Hands-On and Non-Hands-On Treatment Groups on Computer Anxiety, Computer Confidence, Locus of Control, Arousal-Seeking Tendency, and Coping Style Measures

Treatment Group	Computer Anxiety		Computer Confidence		Locus of Control	Arousal-Seeking Tendency	Coping Style
	Pre	Post	Pre	Post			
Hands-on	17.9	17.5	30.5	31.6	10.3	-19.7	1.79
No Hands-on	20.3	19.3	29.5	30.0	10.3	-26.0	3.11

The distributions by sex in the hands-on and no hands-on treatment groups were 26 males and 25 females, and 35 males and 33 females, respectively. The mean age of subjects in each group was 21 years. The mean pre- and post- anxiety, pre- and post-confidence, locus of control, arousal-seeking tendency, and coping style scores for the hands-on treatment group and the other treatment group are summarized in Table 1. Pretest computer anxiety and coping styles were significantly different ($p < .05$) for the two treatment groups.

The two groups had similar computer experience prior to the study (See Table 2). The only significant ($\alpha = .05$) differences in reported previous experience between the treatment groups was in the category of computer programming, with the hands-on subjects averaging approximately six more programming experiences than the other treatment subjects. The largest gain in computer experience for both treatment groups was in the category of database and spreadsheet use, because the lab instruction primarily covered computer spreadsheet applications. The subjects in each group waited an average of three to four days to work on computers after of class.

Table 2
Comparisons of Means for Hands-On and Non-Hands-On Treatment Groups on Pre- and Post Measures of Computer Experience for Wordprocessing, Spreadsheet/Database, Programming, and Recreation

Treatment Group	Wordprocessing		Database/ Spreadsheet		Programming		Recreation	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Hands-on	1.69	1.92	0.73	1.51	1.73	2.06	2.82	3.22
No Hands-on	1.70	2.07	0.70	1.42	1.12	1.39	2.83	3.15

NOTE. 1 = none; 2 = one to 10 times; 3 = 11 to 20 times; etc.

Analyses of variance for the eight research hypotheses showed no significant differences between the treatment groups, or the interactions, on the repeated measures of computer anxiety and computer confidence. Analyses of the journal entries, however, suggest some perceptual or experiential differences between the groups.

Journals

Categories of the subjects' perceptions were determined on the basis of the content of the entries in the ten journals. Journal entries were then coded by category, treatment, sex, and time period. Frequencies of coded entries were placed into a matrix (See Table 9, next page) in order to analyze changes over time and to identify trends in the entries by treatment group.

Some trends from the matrix analysis include the different distribution of comments between the two groups regarding either dislike for the laboratory instruction or dislike for the learning environment. Two entries (or .50 entries per subject) from the journals of the hands-on during instruction treatment subjects and 14 entries (or 2.33 entries per subject) from the other treatment subjects expressed a dislike for lab instruction or environment. Many more subjects in the treatments not having hands-on experience during instruction were negative about the laboratory learning experience.

A second unbalanced distribution was also identified from entries describing a liking for the laboratory instruction and learning environment. Six comments (or 1.50 entries per subject) by the hands-on treatment and two (or .33 entries per subject) by the other treatment were about liking the laboratory sessions. Hands-on treatment subjects made positive statements about the laboratory learning experience at a higher rate.

Table 9
Matrix of the Ratio of Coded Comments in Journals to Number of Subjects in the Hands-On and Non-Hands-On Treatment Groups by Two Week Time Period

Comment Category	First Two Weeks		Second Two Weeks		Third Two Weeks		Fourth Two Weeks	
	H*	N**	H	N	H	N	H	N
Anxiety	.75	.33	.25	.00	.00	.00	.00	.17
Negative Feelings	.50	.00	.25	.17	.25	.50	.00	.17
Dislike Lab Instructn.	.00	.33	.25	.33	.00	.50	.25	.33
Dislike Lab Envirnmt.	.00	.67	.00	.00	.00	.00	.00	.17
Confidence	.75	.50	.25	.00	.25	.33	.25	.00
Positive Feelings	.25	.25	.00	.17	.00	.00	.25	.67
Like Lab Instruction	.25	.17	.25	.17	.00	.17	.25	.00
Like Lab Envirnmt .	.25	.00	.00	.00	.25	.00	.25	.00
Internalization	.00	.00	.00	.00	.00	.17	.75	.17

NOTE. Values shown are the ratio of responses to the total number of subjects in group

*	Hands-on During Instruction Treatment Group	*n* = 4
**	No Hands-on During Instruction Treatment Group	*n* = 6

Entries specifically about the laboratory environment also showed differences between the treatment groups. All three positive comments about the laboratory environment were made by subjects in the hands-on treatment group. All five negative comments about the laboratory environment, on the other hand, were by subjects in the other treatment group.

Another pattern appeared as a change in the ratio of entries over time. In the category of negative feelings, the ratio of the number of entries per subject by the hands-on treatment subjects to the number of entries per subject by the other treatment subjects changed from 4.50:1.00 over the first four weeks to 1.00:2.33 over the last four weeks of the study. Entries were also analyzed by sex of the subject. While female subjects did report more thoughts and feelings overall than males, there were no discernable patterns of either positive or negative entries favoring either sex.

Discussion

The nonsignificant results of the analyses of variance may be due to the short treatment time. Honeyman and White (1987) only found significantly improved state anxiety scores for subjects after approximately 24 hours of hands-on computer instruction. Howard, Murphy and Thomas (1987) found no differential effects by treatment on computer anxiety after approximately 12 hours of hands-on computer instruction. These studies suggest that more hands-on computer experience during instruction, than the approximately three and one-half hours of treatment in this study, may be necessary to show significant differences between treatments.

The design of the study limited the treatment time to one-half of the laboratory instruction in the course as a compromise between the desire to have the maximum amount of treatment and the ethical considerations of all of the students enrolled in the course. The researcher did not want to put any students, whether participating or not participating in the study, at a large disadvantage of any type over the entire period of the course. Grades of some students on some of the assignments might have been influenced by the experiences related to the treatments. Limits on the availability of the computer facility used in the study did not allow for alternative designs which might ethically allow a longer treatment period, such as letting all sections use the facility the second half of the semester.

The low nonsignificant relationship of computer skill mastery level with computer confidence and anxiety is suggested within some of the anxiety literature. Eysenck (1984) explains that the performance levels of high anxiety and low anxiety subjects does not differ by a large degree. He summarizes the research that suggests highly anxious learners typically compensate for decreased cognitive abilities (due to anxiety) by increasing their effort on the learning task.

Analysis of variance calculations showed computer anxiety for the total sample to vary significantly by subjects' externality. This fact supports the computer anxiety literature, that locus of control is more directly related to computer anxiety than is achievement. The perception of control over ones success or failure with computers is related to the degree of anxiety one feels when interacting with computers (Bloom, 1985; Honeyman & White, 1987; Meier, 1985).

Changes in computer confidence significantly interacted with time for the total sample, while changes in computer anxiety did not significantly interact with time. This suggests that the effect of both treatments during the three and one-half hours of on task instruction over eight weeks is sufficient to produce significant changes in the confidence of learners. This also suggests that significant changes in confidence toward computers may take place more easily than changes in computer anxiety, or that the computer confidence subscale may be more sensitive than the computer anxiety subscale to the changes occurring in the subjects during the study.

While, statistical analyses showed no significant differences on the measures in the eight research hypotheses, analyses of the journal entries of the subjects in the two treatments did suggest some differences. The hands-on computer experience during instruction treatment subjects showed more positive and fewer negative journal entries than the other treatment. The hands-on treatment groups also reported a decreased number of negative feelings, while the other treatment groups recorded an increased number of negative feelings from the first half to the last half of the study. These patterns suggest that some differences by treatment groups, not significantly measurable by the instruments, may have occurred in the thoughts and feelings of the subjects during the period of the study.

When the hands-on treatment subjects were asked on the posttest "How did your having an opportunity to work at the computer during the computer lab classes affect your learning?", 53% of those subjects responded that "it helped my learning a lot," and 86% of those subjects reported that it helped to some extent. When asked a similar question "How did your having an oppor-tunity to work at the computer during the computer lab classes affect your confidence?" 32% of those subjects responded that it helped a lot, and 82% reported that it helped to some extent.

In spite of the implied changes in the affect of the subjects, these results suggest that more than the eight hours of instruction and three and one-half hours of hands-on computer practice during instruction may be necessary to significantly change learners' computer anxiety scores over non-hands-on treatments. Especially when working on relatively advanced computer skills,such as spreadsheet applications, in an introductory computer class with a minimum of laboratory experience, more time interacting with computers may be needed to make a significant impact on the computer anxiety levels of students.

Attendance of the laboratory sections differed significantly by treatment group, only 41% of the hands-on treatment group reported attending all eight laboratory classes during the study, while 74% of the subjects in the other treatment group reported attending all eight laboratory sections. The fact that both hands-on treatment groups met on Friday afternoon, while the other treatments met on Monday and Wednesday afternoon, may account for the attendance differences. The overall effect may have been minimal, only 11.8% and 7.2% of the hands-on and other treatment group subjects, respectively, missed more than one class. A cause of this difference in attendance rates may have been the different laboratory class location, about one-half mile from the Business College building, for the hands-on treatment group.

Another problem involved a potential leveling effect. On the pretest measure of computer anxiety, 10 subjects (8.3% of the sample) scored a ten---the lowest possible score---reflecting a lack of measurable computer anxiety. These subjects would not be able to show improvement to their posttest scores. Eight other subjects (6.7% of the sample) scored an eleven and had little chance of significantly improving their scores. A majority of these (ten subjects) were in the hands-on treatment groups (20% of that sample) compared to eight in the non-hands-on (12%), were in this range of extremely low computer anxiety scores. These differences may have impacted on the results.

Additionally, the instructors had not previously taught this class in a computer laboratory. One of the instructors was able to adjust the instruction in the new environment to keep the subjects on task when giving individual help. The other instructor, however, had some difficultly. Only after three weeks of treatment did this instructor become comfortable with teaching in the new environment. Several of the students were observed to be visibly distressed by the lack of attention for up to five minutes at a time. This confounding condition may have diminished the effects of the hands-on treatment for some students in that treatment class.

Summary

Analyses of sex, arousal seeking tendency, coping style, locus of control, and computer skill mastery on changes in computer anxiety and confidence showed no significant differences by treatment. Additional qualitative and quantitative data, however, suggested that the treatments may have had different affective effects on the some perceptions of the subjects. These results suggest that for short periods of time hands-on vs. non-hands-on instruction may not make very much difference in the anxiety, confidence, and performance of young relatively motivated learners. However if other affective concerns, such as attitudes, are important factors, then hands-on computer instruction is preferred.

A need for further research is suggested using similar treatments to this study, but with more sections involved, over a longer time period, with a delayed post-test the following semester. Such a study would better examine the effects of the treatment in a natural setting over the typical time period of an introductory course, as well as the long range effects of the instruction, while reducing some of the confounding variables and limitations of this study.

REFERENCES

Banks, M. J., & Havice, M. J. (1989). Strategies for dealing with computer anxiety: Two case studies. Educational Technology, 24(1), 22-26.

Berlyne, D. E. (1960). Conflict, arousal, and curiosity. New York: McGraw-Hill.

Bloom, A. (1985). An anxiety management approach to computer anxiety. Training and Development Journal, 39(1), 90-94.

Cambre, M. A., & Cook, D. (1985). Computer anxiety: Definition, measurement, and correlates. Journal of Educational Computing Research. 1(1), 37-54.

Cambre, M. A., & Cook, D. (1987, December). Measurement and remediation of computer anxiety. Educational Technology, pp. 15-20.

Cattell, R. B., & Scheier, I. H. (1958). The nature of anxiety: A review of thirteen muLtivariate analyses comprising 814 variables. Psychological Reports, 4, 351-388.

Dick, W., & Carey, L. (1985). The systematic design of instruction (2nd ed.). Glenview, IL: Scott, Foresman and Company.

Ernest, P. S., & Lightfoot, R. M. (1986, November). A Model to Reduce Anxiety and Increase Utilization of Computers in the Classroom. Paper presented at the meeting of the National Council of States on Inservice Education Nashville, TN.

Eysenck, M. W. (1984). A handbook of cognitive psychology. London: Erlbaum.

Eysenck, M. W. (1979). Anxiety: A reconceptualization. Journal of Research in Personality, 13, 363-385.

Fiske, D. W., & Maddi, S. R. (Eds.). (1961). Functions of varied experience. Homewood, IL: Dorsey Press.

Gagne, R. M. (1977). The conditions of learning (3rd ed.). New York: Holt, Rinehart, and Winston.

Gressard, C., & Loyd, B. H. (1984, April). An investigation of the effects of math anxiety and sex on computer attitudes. Paper presented at the meeting of the American Educational Research Association, New Orleans.

Gressard, C., & Loyd, B. H. (1986). The nature of correlates of computer anxiety in college students. Journal of Human Behavior and Learning. 3(2), 28-33.

Harrow, M., & Ferrante, A. (1969). Locus of control in psychiatric patients. Journal of Consulting and Clinical Psychology, 33, 582-589.

Hines, M., & Mehrabian, A. (1979). Appraoch-avoidance behaviors as a function of pleasantness and arousing quality of settings and individual differences in stimulus screening. Social Behavior and Personality. 7(2), 223-233.

Honeyman, D. S., & White, W. J. (1987, Winter). Computer anxiety in educators learning to use the computer: A preliminary report. Journal of Research on Computing in Education. pp. 129-138.

Howard, G. S. (1984). Computer anxiety and the use of microcomputers in management. Ann Arbor: UMI Research Press.

Howard, G. S., and Smith, R. D. (1986). Computer anxiety in management: Myth or reality? Communications of the ACM. 29, 611-615.

Howard, G. S., Murphy, C. M., & Thomas, G. N. (1987). Computer anxiety considerations for design of introductory computer courses. Educational Research Quarterly. 11(4), 13-22.

Johanson, R. P. (1985, April). School computing: Some factors affecting student performance. Paper presented at the meeting of the American Educational Research Association, Chicago.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), Instructional-design theories and models: An overview of their current status (pp. 383-434). Hillsdale, NJ: Lawrence Erlbaum Associates.

Keller, J. M., & Kopp, T. (1987). Applications of the ARCS model of motivational design. In C. M. Reigeluth (Ed.), Instructional theories in action: Lessons illustrating theories and models (pp. 289-320). Hillsdale, NJ: Lawrence Erlbaum, Publisher.

Keller, J. M., & Suzuki, K. (1988). Use of the ARCS model in courseware design. In D. H. Jonassen (Ed.), Instructional designs for computer courseware (pp. 401-434). New York: Lawrence Erlbaum, Publisher.

Lazarus, R. S. (1966). Psychological stress and the coping process. New York: McGraw-Hill.

Lewis, L. H. (1988). Adults and computer anxiety: Fact or fiction? Lifelong Learning: An Omnibus of Practice and Research, 11(8), 5-8, 12.

Loyd, B. H., & Gressard, C. (1984, February). The effects of sex, age, and computer experience on computer attitudes. Paper presented at the meeting of the Eastern American Educational Research Association, West Palm Beach, FL.

Loyd, B. H., & Gressard, C. (1984). Reliability and factorial validity of computer attitude scales. Educational and Psychological Measurement. 44, 501-505.

Loyd, B. H., Loyd, D. E., & Gressard, C. (1987). Gender and computer experience as factors in the computer attitudes of middle school students. Journal of Early Adolescence. 7(1), 13-19.

Malmo, R. B. (1971). Studies of anxiety: Some clinical origins of the activation concept. In C. D. Spielberger (Ed.), Anxiety and Behavior (pp. 157-177). New York: Academic Press.

Mathis, A., Smith, T., & Hansen, D. (1970). College students' attitudes toward computer-assisted instruction. Journal of Educational Psychology. 61(1), 46-51.

Mehrabian, A. (1978). Characteristic individual reactions to preferred and unpreferred environments. Journal of Personality, 46, 717-731.

Mehrabian, A., & Russell, J. A. (1974). An approach to environmental psychology. Cambridge, MA: Massachusetts Institute of Technology Press.

Mehrabian, A., & West, S. (1977). Emotional impact of a task and its setting on work performance of screeners and nonscreeners. Perceptual and Motor Skills, 45, 895-909.

Meier, S. T. (1985). Computer Aversion. Computers in Human Behavior. 1, 171-179.

Miles, M. B., & Huberman, A. M. (1984). Qualitative data analysis: A sourcebook of new methods. Beverly Hills, CA: SAGE Publications.

Miller, S. M. (1987). Monitoring and blunting: Validation of a questionnaire to assess styles of information seeking under threat. Journal of Personality and Social Psychology, 52, 345-353.

Morrow, P. C., Prell, E. R., & McElroy, J. C. (1986). Attitudinal and behavioral correlates of computer anxiety. Psychological Reports. 59 , 1199-1204.

Phares, E. J. (1976). Locus of control in personality. Morristown, NJ: General Learning Press.

Powers, W. G., Cummings, H. W., & Talbott, R. (1973). The effects of prior computer exposure on man-machine computer anxiety. ERIC Document Number 089 763.

Raub, A. C. (1981). Correlates of computer anxiety in college students. Unpublished Ph.D. dissertation, University of Pennsylvania.

Rohner, D. J., & Simonson, M. R. (1981, April). Development of an index of computer anxiety. Paper presented at the meeting of the Association for Educational Communications and Technology, Philadelphia.

Rosen, L. D., Sears, D. C., & Weil, M. M. (1987). Computerphobia. Behavior Research Methods, Instruments, and Computers. 19, 167-179.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 80, (1, Whole No. 609), 1-28.

Rotter, J. B. (1975). Some problems and misconceptions related to the construct of internal versus external control of reinforcements. Journal of Consulting and Clinical Psychology, 43, 56-67.

Russell, J. A., & Mehrabian, A. (1975). Task, setting, and personality variables affecting the desire to work. Journal of Applied Psychology. 60, 233-252.

Sanders, J. S., & Stone, A. (1986). The neuter computer: Computers for girls and boys.

New York: Neal-Schuman Publishers, Inc.

Simonson, M. R., Mauer, M., Torardi, M. M., & Whitaker, M. (1987). Development of a standardized test of computer literacy and a computer anxiety index. Journal of Educational Computing Research. 3, 231-247.

Sparks, G. S., & Spirek, M. M. (1988). Individual differences in coping with stressful mass media. Human Communication Research, 15, 195-216.

Tobias, S. (1979). Anxiety research in educational psychology. Journal of Educational Psychology, 71, 573-582.

Tucker, D. M. (1986). Neural control of emotional communication. In P. D. Blanck, R. Buck, & R. Rosenthal (Eds.), Nonverbal communication in clinical context. (pp. 258-307). University Park: Pennsylvania State University Press.

Tucker, D. M., & Williamson, P. A. (1984). Asymmetric neural control systems in human self-regulation. Psychological Review, 91, 185-215.

Widmer, C., & Parker, J. (1983). Micro-anxiety: How to beat it before you get it. Electronic Education, 3(3), 23-24.

Winkle, L. W., & Mathews, W. M. (1982). Computer equity comes of age. Phi Delta Kappan, 63, 314-315.

Wolleat, P., Pedro, J. D., Becker, A. D., & Fennema, E. (1980). Sex differences in high school students' causal attributions of performance in mathematics. Journal for Research in Mathematics Education, 11, 356-366.

Zelman, S. (1986). Motivational differences in learning about computer hardware and software: Implications of students' ideas about intelligence. Educational Technology, 26(8), 15-20.

Title:

The Psychology of Hypermedia: A Conceptual Framework for R & D

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THE PSYCHOLOGY OF HYPERMEDIA: A CONCEPTUAL FRAMEWORK FOR R&D

Introduction

> "More new information has been produced in the last 30 years than in the previous 5,000. About 1,000 books are published internationally every day and the total of all printed knowledge doubles every eight years."
> — Peter Large

> "We are like a thirsty person who has been condemned to use a thimble to drink from a fire hydrant."
> — Richard Saul Wurman

Think about a close friend. Perhaps she is an accountant. The concept of accountant is associated with many other concepts and ideas — taxes, green visors, a love of numbers, etc. Your friend has many attributes associated with her (e.g.,she is slender, she likes horror movies, she dresses elegantly, etc.) only one of which is that she is an accountant.

Now suppose a colleague complains about having to prepare this year's tax return. Your colleague's grousing triggers your thoughts about the concept of "accountant" which are, in turn, associated with your friend. Thinking about your friend now may remind you that you are scheduled to see a movie together on Friday, which may cause you to think of one of your favorite horror movies.

The mind seems to operate through associations. How else, then, could one go from a thought of accounting to thinking about horror stories? Thoughts often trigger other thoughts. Indeed, mental concentration is nothing more than the effort exerted to keep the mind from associating too much—to keep it focused on one thing at a time. Without the mind's penchant for associations, how could classical or operant conditioning be so powerful? Why would the creativity technique of *mindmapping* have become so popular? Why would hearing an old song send many into an ecstasy of nostalgia? And why else would educators assert that the best way to make new material meaningful is to relate it to knowledge already in the brain? However the brain works, it is anything but linear.

Consider how one might classify a Dalmatian dog. As a dog? A pet? A spotted animal? A mammal? A fireman's companion? Clearly, the world resists classification into single, linear hierarchies; a Dalmatian can be associated with any number of other things. Now try to imagine the best way to classify a mouse. As a member of a group of animals called rodents? As a strange pet to have? As an undesirable house companion? Mice, like Dalmatians and everything else in the world, can fall under any number of classification schemes. Indeed, the Dalmatian and the mouse, both mammals, can also be classified as popular animated Disney characters.

The meaning we ascribe to a concept depends entirely on which classification scheme or set of associations is accessed. This access depends on the situation (i.e. context). Indeed, to the age-old question, "What is the meaning of life?", the answer is probably, "It depends." It depends on how we look at things, when we look at them, and even to what things we choose to attend. In other words, it depends upon how we construct our personal reality—how we perceive the world and even what we choose to include in our view of it.

If both the brain and the world around us consist of networks of highly interconnected ideas, concepts, processes and events, then linear educational media such as books and videotape are sorely inadequate to deal with this ever-expanding universe of information—highly interconnected, dynamic information. A new way of accessing and processing this information is needed.

This "new" idea was actually proposed almost fifty years ago. The man who proposed this new scheme knew much about the associative nature of both the brain and the world and also knew about how meek the tools of his time were for storing, accessing and using a steadily accumulating mass of information. The year was 1945 and the man was Vannevar Bush, science advisor to Franklin Roosevelt. Then, as now, scientific knowledge was accumulating at a rate far exceeding anyone's ability to make effective use of it. Bush believed that to enhance the acquisition of knowledge and to assist in viewing information in new and useful ways, one might wish to follow various trails, perhaps to wander off on a tangent and later return to the mainstream. For this endeavor, paper was clearly inadequate. Bush's answer to the paper dilemma was the *memex*. In his own words,

> A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory. (pp. 106-107).

Bush later states,

> It affords an immediate step, however, to associative indexing, the basic idea of which is a provision whereby any item may be caused at will to select immediately and automatically another. This is the essential feature of the memex. The process of tying two items together is the important thing. (pp. 107).

Although the memex was never built, Bush set forth a vision that took almost half a century to materialize. The memex was the conceptual parent of what we now call *hypertext*.

Hypertext/Hypermedia

> Imagine a new accessibility and excitement that can unseat the video narcosis that now sits on our land like a fog. Imagine a new libertarian literature with alternative explanations so anyone can choose the pathway or approach that best suits him or her; with ideas accessible and interesting to everyone, so that a new richness and freedom can come to the human experience; imagine a rebirth of literacy. (Nelson, 1987; p. 1/4)

Despite its proclamation as a revolutionary information and learning tool, as a weapon believed to be a bastion of democracy and freedom, hypertext has always seemed like a solution in search of a problem—or perhaps a solution whose problems might outweigh its benefits. Yet it has an intuitive appeal that persists. It seems to be one of those things that we **know** is right because it just **feels** right. It is this intuitive appeal, recently proposed cognitive learning theories, and dizzying progress in technology that have synergistically fueled the hypertext mania.

Most discussions about hypertext tend to expound the virtues of hypertext and then go on to explain the fortuitous coincidence of how this new technology happens to mirror the functioning of the brain—a solution looking for a problem to solve. The approach taken in this paper is the inverse of such an approach. We will start with an examination of theories and studies regarding how people learn, access and use information and ideas, and only then move to consider the new technology that may mirror the way our brains work.

Brief Glossary of Terms

What exactly is hypermedia anyway? There is often some confusion regarding exactly what hypermedia is and what it is not. Five terms—interactive video, interactive multimedia, multimedia, hypertext and hypermedia—are often used interchangeably yet represent distinct ideas.

Interactive video (IV) combines the "interactive capability of the computer with the unique properties of video presentations" (Chen, 1990; p. 6). The typical interactive video arrangement includes a videodisc player connected to a personal computer, with the computer controlling the presentation of the video in response to interaction with the user. IV refers specifically to the **computer-videodisc player** combination. IV is a subset of interactive multimedia (see Evans, 1986).

Interactive multimedia refers to any computer-based configuration in which some combination of video, computer-generated graphics, sound, animation, and voice is used (see Ambron and Hooper, 1988, 1990; Stefanac and Weiman, 1990). These multimedia elements can either come from external sources such as videodisc players, VCRs or audio equipment, or they can be generated internally such as when video, sound or graphics are stored digitally on a hard disk or optical disk. What gives interactive multimedia its interactivity is the computer. Without the computer, the result is simply multimedia.

Of all the five terms, *multimedia* is the most difficult to define. The term has been used to refer to everything from slide shows to extravaganzas complete with multiple monitors, animation, video, sound and text. It would be easy to remember that multimedia stands for multiple media except that the term media can mean many things. "Media" can include slides, audiotapes, videotapes, videoconferencing, animation, films, music, voice, paper, or even someone shouting through a megaphone. Media can be instructional or not; it can be interactive or not; and it can be computer-based or not. While the focus of interactive video, interactive multimedia, and multimedia is on the technology, the focus of *hypermedia* is on method—a method that so happens is most suited to the computer.

Understanding hypermedia depends on an understanding of its related term, *hypertext*. Quite different from the continuous flow of text inherent in traditional presentations of information, hypertext breaks up the flow into modules. "By modularizing information, users have the option of selecting the next module, which may include an elaboration or example of the present idea or an entirely new idea to be compared with the previous one." (Jonassen, 1989; p. 7).

Hypertext is often described as a computer-based method of nonsequential reading and writing—a technique with which chunks, or *nodes*, of information can be arranged and rearranged according to an individual's needs, previous knowledge, curiosities, etc. (Conklin, 1987; Jonassen, 1989; van Dam, 1988; Begoray, 1990; Hall and Papadopoulos, 1990). Hypertext not only *presents* information as a book does, it also *represents* information. As discussed earlier in this paper, meaning is derived from the arrangement of information. The implication here is two-fold: 1) Meaning is not static, but rather, dynamic—changing as the arrangement of nodes changes, and 2) Meaning resides in the relationships between the nodes, not in the nodes themselves. This insight is intriguing and has exciting implications for learning. According to Kearsley (1988), hypertext should improve learning by focusing attention on the relationships between ideas rather than on isolated facts. Associations provided by the links in hypertext should facilitate retrieval, concept formation, and comprehension.

Hypermedia, a term often used interchangeably with hypertext, is simply multimedia hypertext (Nielsen, 1990). That is, hyper*media* extends hyper*text* to include the full range of information forms: sound, graphics, animation, video, music, as well as text. As hypermedia is the more inclusive of the two terms, this paper will use the term hypermedia as a catch-all term referring to both text-based and multiple media-based systems.

The remainder of this paper will explore the insights that psychology can offer in shedding light on why hypermedia may work and thus in suggesting fruitful areas for future research. It is in this spirit that we should explore some of the psychological underpinnings of hypermedia.

Some Psychological Underpinnings of Hypertext

Humans are perceived by cognitive theorists as being processors of information, acquiring knowledge and skills by way of interactive internal processes. These internal processes are orchestrated by a set of control processes which are personal, reflective of both innate abilities and individual experience.

Theories proposed by cognitive psychologists as well as strategies employed by cognitively oriented educators and instructional designers exhibit a basic cohesion in that humans are viewed as processing information by actively attending to stimuli, accessing existing knowledge to relate to new information, realigning the structure of that existing knowledge to accommodate new information, and encoding restructured knowledge into memory (Jonassen, 1985). The meaning that the individual ascribes to information is viewed as idiosyncratic, actively constructed from a base of existing knowledge (Winn, 1988). Our active participation in the construction of this new knowledge is viewed as a critical component for accessing and retrieving prior knowledge in the interpretation of new information (Weinstein, 1978). Thus, as we explore some of the ideas of what we know about how we learn and apply knowledge, it becomes obvious that activity as well as interactivity are integral components of both theory and its application in the technology of hypermedia.

Cognitive Flexibility Theory

Many instructional systems fail, claim Rand Spiro and colleagues, because they do not take into consideration the *ill-structuredness* of many complex domains (Spiro and Jehng, 1990; Spiro, Feltovich, Jacobson, and Coulson, 1991). *Cognitive flexibility theory* is an attempt to explain how the brain makes sense of ill-structured domains (i.e. domains that are complex and in which there is little regularity from one case to another).

Essentially, the theory states that cognitive flexibility is needed in order to construct an ensemble of conceptual and case representations necessary to understand a particular problem-solving situation. The idea is that we cannot be said to have a full understanding of a domain unless we have the opportunity to see different case representations.

According to Spiro et al., advanced knowledge requires an approach to learning that is quite different from that of introductory learning. The fundamental problem running throughout many learning efforts is "oversimplification." Oversimplification occurs in different forms. For example, *additivity bias* occurs when parts of complex entities are studied and it is assumed that these parts could be then re-integrated as a whole while retaining their original complex characteristics. Another example is *discreteness bias,* where continuous processes are divided up into discrete steps. Yet another form of oversimplification includes the *compartmentalization bias*, in which highly interrelated, interdependent concepts are considered in isolation from one another without consideration of how they interact.

Cognitive flexibility theory is an answer to the necessity of mastering complex subjects without falling prey to oversimplification in any or all of its forms. Basically, the theory posits that in order to learn complex material, the learner has to see that same material at different times, in different situations, for different purposes and from different conceptual perspectives (Spiro, Feltovich, Jacobson, and Coulson, 1991). Complete schemata are constructed to the extent that learners are exposed to multiple knowledge representations and multiple interconnectedness of the complex material to be learned.

Given the tenets of cognitive flexibility theory and what we know about the unique characteristics of hypermedia, it is easy to see the promising fit between the technology of hypermedia and the manner in which we allegedly best learn complex subject material. To make the potential fit of hypermedia to cognitive flexibility theory even stronger, recall that hypermedia is nothing more than a tool to link together nodes (chunks of information, or "conceptual elements") together in meaningful ways. This capability matches precisely the requirements of cognitive flexibility theory—the ability to see different aspects of a complex subject area from different perspectives in different contexts.

Hypermedia, therefore, has properties that are consistent with cognitive flexibility theory. For example, conceptual elements in the hypermedia environment can be re-arranged so that several conceptual elements can be viewed together. For another purpose, or in a different situation, conceptual elements could be arranged differently. Recall that it is the arrangement and relationships among nodes that give meaning to information. By freely rearranging nodes according to specified features/properties depending on different needs, different contexts and different problems, learners have a powerful tool with which to learn and understand complex material in all its forms, in different situations, and in its entirety.

Even though hypermedia has been accused of being a solution in search of a problem, it is exciting to contemplate the idea that hypermedia may be just the opposite, a solution to the very tricky problem of how to effectively and efficiently teach complex, multifaceted subjects with many interconnected elements, such as medicine, literature, economics, etc. Given the almost made-to-measure fit of hypermedia to cognitive flexibility theory, it is important that we make it our top priority to take a closer look at *how* it fits and, perhaps more importantly, *why* it fits. Further research is required to clarify exactly how the brain deals with complex subject matter and how hypermedia systems can be shaped to facilitate optimal learning.

Information Processing

Information processing is proposed as an interactive system. An individual uses the physical senses to make sense out of the stimuli of the environment. This sensory recognition is interrelated with the individual's long-term memory, experiences, abilities, and expectations. Information is first received and recognized and is then either encoded and stored for later retrieval or is lost. The stages of information processing— recognition, short-term (working) memory storage, and long-term memory storage— are dependent on internal processes. What we remember, therefore, is a result of interactions within this system of active internal processes.

The system processes information by first recognizing patterns. If information is first recognized, it can then take on meaning. To extend our discussion of the concept of the Dalmatian dog, for example, we would first process the information presented by recognizing the pattern of the letters *DOG*. The combined alphabet letters *D*, *O*, and *G*, however, are not just recognized as individual letters in terms of how they are shaped; they represent a host of associations which have already been mentioned. Whether we are able to recognize this word and give it meaning each time we see the letters *DOG* depends on whether the information about *DOG* is stored in long-term memory and can be retrieved into short-term memory (working memory) when called upon.

According to information processing theory, retention of information is attributed to basic processes—attention, selective perception, rehearsal, encoding, and retrieval—all of which occur throughout the three information processing stages. Current theorists put more emphasis on these processes and how they are affected rather than the stages in which they occur. To increase the probability that information is acquired, stored, and retrieved, we must somehow affect attention, selective perception, rehearsal, encoding, and retrieval. As processing occurs, information and skills are recoded to form stronger links to nodes and more pathways to stored information. According to theorists, information must be adequately encoded, stored, and retrieved to be remembered. Thus, ***any*** retention aid should encourage extra processing of information to increase links to stored skills. According to Tulving and Thomson (1973), the degree of accessibility of information stored in long-term memory is dependent on the strength of the cues encoded during acquisition. Strong cues, such as those cues which may be generated in hypermedia, are more likely to be present at recall.

Case-Based Reasoning

Case-based reasoning is an exciting educational paradigm in which learning depends on memory of specific experiences, or "cases" (Riesbeck and Schank, 1989). Medical and law schools have long utilized case-based instruction techniques in their curricula. Cases provide the means with which students can learn why, when, and how knowledge is applicable. In order to avoid the "inert knowledge problem" (see Whitehead, 1929; Bransford, Sherwood, Vye, & Rieser, 1986), learners must have the opportunity to organize new knowledge appropriately and know how and in what situations to apply the knowledge. The important point here is that instruction is more effective when anchored in meaningful problem-solving environments similar to those in which students will find themselves when solving actual real-world problems.

If the usefulness of information depends on an ability to recall it when appropriate, then it is important that cases be presented in such a way as to provide contextual cues to properly index information in memory. Hypermedia may facilitate this indexing by presenting information along with appropriate contextual cues. Ferguson et al. (1991) have created a hypermedia case-based learning environment that helps organize information the same way in which the information will have to be organized when applied to some task.

Generative Learning

Cognitive principles suggest that learning is an active, constructive process in which learners generate meaning for information by accessing and applying existing knowledge. Generative learning theory incorporates these principles of cognitive psychology (Wittrock, 1974a, 1974b, 1979). The theory maintains that meaning for material is generated by activating and altering existing knowledge structures to interpret new information and encode it effectively for future retrieval and use. In Wittrock's (1974b) model, meaningful learning is a rational and transferable process:

> … the generative model predicts that learning is a function of the abstract and distinctive, concrete associations which the learner generates between his prior experience, as it is stored in long-term memory, and the stimuli. Learning with understanding, which is defined by long term memory plus transfer to conceptually related problems, is a process of generating semantic and distinctive idiosyncratic associations between stimuli and stored information. (p. 89)

Comprehension, according to the generative model, requires the proactive transfer of existing knowledge to new material. Wittrock (1990) maintains, for example, that generative reading focuses on constructive or generative processes usually considered characteristic of good written composition. In other words, reading, like good writing, involves generative cognitive processes that create meaning by building relations among the parts of the text to be learned as well as between the text and what the learner knows, believes, and experiences. Learning activities which require the learner to relate new information to an existing knowledge structure depend on complex cognitive transformations and elaborations that are individual, personal, and contextual in nature. Generative learning activities, then, can be thought of as strategies which foster not only learning but learning-to-learn (Brown, Campione, & Day, 1981). In these learning activities, information is transformed and elaborated into a more individual form for the learner, thereby making the information more memorable as well as more comprehensible.

Semantic Networks

The nature of traditional media such as paper and video forces a linearity onto its content. Authors must arrange their work hierarchically so that one idea flows to the next and where ideas are subsumed under other ideas. As we have discussed earlier, however, the mind is anything but a linear thinking machine. Ideas are *not* arranged as on a scroll with one neatly leading to the next. In fact, it appears that the mind consists of endlessly intertwined webs of interrelated ideas, emotions and skills.

Quillian (1968) developed the idea of active structural networks (ASN) in an effort to capture and depict the ostensibly network-like nature of the brain. These networks consist of nodes (chunks of information) and labeled links (relationships) between nodes. Allegedly, everything someone might know could be encoded into the active structural networks of the brain. Furthermore, networks serve as structures within which new information is integrated with knowledge already possessed by the learner. The implication, then, is that learning involves the acquisition of new chunks of information and their connection to related chunks of information both new and old.

It is easy to see how active structural networks function by speaking in terms of schema theory. Schemata consist of interconnected sets of ideas which are further linked to other schemata. Meaningful learning takes place when new ideas are linked to other new ideas and when all are somehow assimilated into existing networks of schemata. While it might seem that the connections between nodes and between schemata are fixed except when new learning is taking place, the fact is quite the opposite. Relationships within and between schemata are defined in terms of context. The implication is that we remember and process ideas differently depending on the context.

It follows that it does not make sense to speak of an Absolute Truth about anything in our world, then, since the meaning of anything depends on how we perceive it in relation to other things. Recall our discussion of the Dalmatian dog. It is not adequately stating the Truth or the final word about Dalmatian dogs to say that they are members of a genus, the canines, within the class called mammals. We are no closer to absolute Truth if we add that they are members of a class of animals that are spotted. The Dalmatian dog is, in fact, a member of an extremely rich and diverse collection of interconnected ideas. It is a type of carnivore which is a family of mammals, but it is also merely a dog. Dogs are associated with other concepts such as companionship, love, and with loud noises. They might also be associated with the thought of a good friend who owns four of them. The Dalmatian dog might also be connected to memories of childhood when the people next door had one. We could go on, *ad infinitum*, adding more and more to our Dalmatian dog schemata, but we could only approach the Truth, never arrive at it. As this demonstration suggests, meaning is *constructed* by each individual and is highly dependent on context. In learning, accessing and applying knowledge, only a small subset of the Truth is ever relevant. Indeed, this position is at the foundation of the increasingly popular educational movement, *constructivism*. Suchman (1987) argues that there is no ultimate reality. Instead, reality is relative and is the outcome of a constructive process. It is one's experience with an idea and the context of which the idea is a part that act together to construct a meaning of that idea (Brown, Collins, and Duguid, 1989).

All of this brings us back to the limitations of paper, video, and other linear systems. If learning involves the manipulation of networks of information and if the relationships binding these networks change depending on the context, the inadequacy of linear systems becomes clear. Within hypermedia, information can be rearranged, analyzed, shifted, and molded to suit the needs of each individual and the context in which the material is learned and/or applied. Hypermedia is a technology which can assist its users in constructing their schemata according to context and to individual needs and characteristics. The exact ways in which hypermedia can be made to facilitate schemata processing, however, requires a good deal more empirical research.

Dual Coding Theory

The central theme underlying semantic network theory is that information is not simply filed away under a single heading, but rather is integrated in some way into a highly interconnected network of data and the relationships between those data. Dual coding theory (DCT) goes further in that it postulates that mental representations of ideas and events are stored in distinct verbal and nonverbal symbolic modes and that these representations retain the pattern of sensorimotor activation present during encoding (Clark and Paivio, 1991; Paivio, 1986).

One of the structural assumptions underlying DCT is that connections are formed both within verbal or nonverbal representations (associative connections) and between the two forms of representation (referential connections). For example, an associative connection would be one in which thinking about computers might remind you of related terms such as monitor, printer, and perhaps even frustration. A referential connection would be present if the word "mouse" conjured up memories of images of mice, the squeaking sounds they make and a sensation of anxiety. Thus, both *inter* and *intra*-associative structures exist between and within the two symbolic systems.

Mental representations are activated by related nodes in the network of associated nodes. Thoughts can activate associated nodes and then spread, resulting in a complex pattern of spreading activation among nodes and links in the network. Returning to our example of the dog,the sight of a Dalmatian dog might trigger the image of your neighbor who owns a Dalmatian. The image of your neighbor might, in turn, activate the thought of "dentist" as that is your neighbor's occupation, which might arouse a sense of uneasiness as you remember your last visit to the dentist.

This last example points out an important assumption of DCT specifically as well as active structural networks generally. As activation of nodes and associations spread out, they tend to weaken. It is easy to see how a thought of a Dalmatian could activate the thought of the dog's owner. It becomes increasingly ridiculous to speak of strong associations between verbal and nonverbal mental representations because, ultimately, everything is related! DCT, then, provides a plausible explanation of how the brain deals with information, in both verbal and nonverbal forms, which are more or less related to one another.

Another interesting aspect of DCT relevant to our discussion of hypermedia is that it emphasizes the role of past experience in the development of mental representations. Although two individuals may have the same experiences, their mental representations of these experiences will be different in significant ways, a function of their past experiences. Insights derived from DCT are consistent with the position taken by constructivists who maintain that there is no Truth out there, but rather that each individual's mental representation of reality is a constructed version of reality, and each person's construction is different from all others.

DCT makes it easy to see how beneficial hypermedia can be. First, one of the implications of DCT is that the more sensory modes in which mental representations are stored, the more likely it is that they will be remembered. Hypermedia makes it easy to access related information in a wide variety of forms. A picture of a human heart can be accompanied by a motion video segment depicting blood flow through the ventricles, detailed drawings, textual explanations of anatomy and processes, and heartbeat sounds. All of this information could be immediately available at the click of an on-screen button. The quick and easy retrieval of related information in its different forms helps to build stronger relationships between these pieces of information than if one had to stop reading a textbook, retrieve a videotape, then an audiotape, then a carousel of slides, etc.

Another implication of DCT is that the mental representations constructed depend on context. If different people construct different representations of reality in order to conform to the context and their experiences, then it follows that any tool that helps people to personalize the information structure would be beneficial.

The idea of spreading activation suggests that it might be useful to assign values to links emanating from each node. The values assigned would represent the strength of the conceptual relationship between nodes. These values would indicate to users which of several links are the strongest, and would thus help users decide which links to traverse. Of course, there is no reason why users could not be provided with the means of assigning values to links themselves. The implications of active structural networks for hypermedia are many and exciting. Much research remains to be done in this area.

Dual coding theory has much to recommend hypermedia. It is a comprehensive theory of learning and suggests many implications for education. Its main idea is that all knowledge is constructed in the brain in many different forms and is different from person to person. All of this points up the need for learning and information acquisition tools that facilitate associative processing of information in a variety of forms, which are, in fact, integral to hypermedia.

Bridging the Gap

> What is hypertext? Hypertext is freedom! Freedom from the burdens of traditional computing applications. Freedom from fear of failure. Every hypertext user succeeds in getting somewhere and getting something. (Shneiderman and Kearsley, 1989; p. 2)

> All of this is manifest destiny. There is no point in arguing it; either you see it or you don't. Many readers will choke and fling down the book, only to have the thought gnaw gradually until they see its inevitability (Nelson, 1987; p. 0/12)

An attempt should be made to bridge the gap between what we know about how we learn and apply knowledge and a new technology that promises to augment the brain's functioning in a way never before possible. Hypertext and hypermedia have been trumpeted as revolutionary devices to help us deal with the geometrically increasing pool of information in the world. Among the many advantages hypermedia, claims include that it increases learner involvement and learner control, it focuses on relationships rather than isolated bits of data, it permits levels of explanations and it is easy to do annotations of all kinds.

All of these benefits are kudos to the technology of hypermedia itself. The technology permits information to be revealed as necessary (levels of explanation) in whatever order/arrangement is necessary (focus on relationships) and among other things, provides a nice method for uncovering side information or adding one's own side notes (annotation). The real intrigue of hypermedia, however, derives from its unique ensemble of characteristics which tantalizingly corroborate evidence regarding the way our brains work.

The idea of a machine based on associative indexing is not new (Bush, 1945), but the technology to materialize the vision is only now becoming available, with exciting new capabilities just over the horizon. While we explore the possibilities, however, we must not forget that the technology must *work for humans*, not the converse.

The philosophy underlying this paper is that research into the instructional efficacy of hypermedia should begin with a knowledge and appreciation of relevant psychological phenomena. This not to say that we should retreat, learn about how we learn and then return with an armload of instructional strategies to be applied to the new technology. Ross and Morrison (1989) put it well,

> Aside from being difficult to accomplish, separating media from methods may not always be desirable in instructional technology research. Although media do not directly affect learning, they serve as influential moderating variables through their effects on learner attributions and their differential properties for conveying instructional strategies.(pp. 29-30).

Knowledge of new technologies offer us new opportunities for understanding how we learn as they provide new capabilities. In turn, knowledge of how we learn feeds back to guide the development of the new technologies, creating a wonderful cycle of progress. Hypermedia has unique characteristics that point us to relevant areas of learning research. Hopefully, an examination of the psychology and learning phenomena will, in turn, inform the research and development of hypermedia, which will then feed back to learning and psychology research, creating a most fecund feedback loop. Perhaps the conceptual father of hypermedia said it best when he wrote:

> There is a new profession of trail blazers, those who find delight in the task of establishing useful trails through the enormous mass of the common record. ...Thus science may implement the ways in which man produces, stores, and consults the record of the race. (Bush, 1945; p. 108)

We are in virgin territory. What is more, we are exploring this unknown territory in the dark. Every bit of knowledge we have about how we learn, process, and apply knowledge is like a spotlight beaming down on a small part of the foreign landscape. The more psychological knowledge we consider, the more spots will become illuminated, making more and more of the terrain visible and understood. But the spotlights are not erratic. They correspond to specific paths, much the same as streetlights light up not the whole city, but specific avenues throughout the city. Our paths lie within the psychology of learning. When aimed down on the unknown territory of the new technology, spotlights could illuminate the right paths that we must take to use the technology to enhance our ability to learn, process, and apply knowledge. This paper is an attempt to fire up as many of these spotlights as possible in order to light the way.

References

Ambron, S., & Hooper, K. (Ed.). (1988). *Interactive multimedia: Visions of multimedia for developers, educators, & information providers*. Redmond, WA: Microsoft Press.

Ambron, S., & Hooper, K. (Ed.). (1990). *Learning with interactive multimedia: Developing and using multimedia tools in education*. Redmond, WA: Microsoft Press.

Begoray, J. A. (1990). An introduction to hypermedia issues, systems and applications areas. *Int. J. Man-Machine Studies*, **33**, 121-147.

Bransford, J. D.,Sherwood, R. S.,Vye, N. J., & Rieser, J. (1986). Teaching thinking and problem solving: Research foundations. *American Psychologist*, **41**, 1078-1089.

Brown, A. L., Campione, J. C., & Day, J. D. (1981). Learning to learn: On training students to learn from texts. *Educational Researcher, 10*, 14-21.

Brown, J.S., Collins, A., and Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, **18**, 32-42.

Bush, V. (1945). As we may think. *Atlantic Monthly,* **Jul**, 101-108.

Chen, L.C. (1990). Interactive video technology in education: Past, present and future. *J. Educational Technology Systems*, **19**(1), 5-19.

Conklin, J. (1987). Hypertext: An introduction and survey. *IEEE Computer*, **Sept.**, 17-41.

Duffy, T.M., & Jonassen, D.H. (1991). Constructivism: New implications for instructional technology?, *Educational Technology*, **May**, 7-12.

Evans, A. D. (1986). Interactive video research: Past studies and directions for future research. *Int'l J. Intstructional Media*, **13**(4), 241-248.

Ferguson, W., Bareiss, R., Osgood, R., & Birnbaum, L. (1991). ASK Systems: An approach to story-based teaching. In Birnbaum, L. (Ed.) *Proceedings of the International Conference on the Learning Sciences*. Association for the advancement of computing in education. Charlottesville, VA.

Hall, P. A. V., & Papadopoulos (1990). Hypertext systems and applications. *Information and Software Technology*, **32**(7), 477-490.

Jonassen, D. H. (1985). Generative learning vs. mathemagenic control of text processing. In D. H. Jonassen (Ed.), *Technology of text: Principles for structuring, designing, and displaying text: Vol. 2* (pp. 9-45). Inglewood Cliffs, NJ: Educational Technology Publications.

Jonassen, D. H. (1986). Hypertext principles for text and courseware design. *Educational Psychologist*, **21**(4), 269-292.

Jonassen, D. H. (1989). *Hypertext/Hypermedia*. Englewood Cliffs, NJ: Educational Technology Publications.

Kearsley, G. (1988). Authoring considerations for hypertext. *Educational Technology*, **Nov.**, 21-24.

Nelson, T. H. (1987). *Literary Machines*. South Bend, IN: The Distributors.

Norman, D. A. (1973). *Cognitive organization and learning*. (Tech Report No. ED 083 543). Center for Human Information Processing. University of California, San Diego.

Norman, D. A. (1976). *Memory & Attention*. New York: John Wiley & Sons.

Norman, D. A., & Rumelhart, D. E. (1975). *Explorations in cognition*. San Francisco: W.H. Freeman Co.

Quillian, M. R. (1968). Semantic memory. In M. Minsky (Eds.), *Semantic information processing* (pp. 216-270). Cambridge, MA: MIT Press.

Riesbeck, C., & Schank, R. (Ed.). (1989). *Inside case-based reasoning*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Ross, S.M., & Morrison, G.R. (1989). In search of a happy medium in instructional technology research: Issues concerning external validity, media replications, and learner control. *ETR&D*, **37**(1), 19-33.

Shneiderman, B., & Kearsley, G. (1989). *Hypertext hands-on*! Reading, MA: Addison-Wesley Publishing.

Spiro, R. J., & Jehng, J. (1990). Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R. Spiro (Eds.), *Cognition, education, & multimedia: Exploring ideas in high technology*. Hillsdale, NJ: Lawrence Erlbaum.

Stefanac, S., & Weiman, L. (1990). Multimedia: Is it real? *Byte*, **Apr**, 116-123.

Suchman, L. A. (1987). *Plans and situated actions: The problem of human-machine communication*. Cambridge, UK: Cambridge University Press.

Tulving, E., & Tompson, D.M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*. 352-373.

van Dam, A. (1988). Hypertext '87: Keynote Address. *Communications of the ACM*, **31**(7), 887-895.

Weinstein, C. E. (1978). Elaboration skills as a learning strategy. In H.F. O'Neil (Ed.), *Learning strategies*. New York: Academic Press.

Whitehead, A. N. (1929). *The aims of education*. New York: Macmillan.

Winn, W. D. (1988). Rethinking instructional design procedures in light of cognitive theory. Unpublished manuscript, University of Washington, Seattle.

Wittrock, M. C. (1974a). A generative model of mathematics learning. *Journal of Research in Mathematics Education, 5*, 181-197.

Wittrock, M.C. (1974b). Learning as a generative process. *Educational Psychologist, 11*, 87-95.

Wittrock, M.C. (1979). The cognitive movement in instruction. *Educational Researcher, 8* (2), 5-11.

Wittrock, M.C. (1990). Generative processes of comprehension. *Educational Psychologist*, *24*(4), 345-376.

Title:

Formative Evaluation: A Revised Descriptive Theory and a Prescriptive Model

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A-B-S-T-R-A-C-T

The premise is advanced that a major weakness of the everyday generic instructional systems design model stems from a too modest traditional conception of the purpose and potential of formative evaluation. In the typical ISD model formative evaluation is shown not at all or as a single, **product** evaluation step. Yet, in practice formative **process** evaluation is also widely accepted as desirable and is more pervasive than the models would indicate because it is done informally. A broader theory of product-plus-process formative evaluation for instructional design is offered. The critical factors of this descriptive theory focus upon the desirability and viability of introducing formative evaluation techniques at the very beginning of the ISD process rather than at the end. A revised purpose of formative evaluation is theorized which envisions an ISD system that provides process feedback as well as product feedback, thus enabling the system to become truly self correcting. In the theoretical structure posited, the output of any observable or definable step in the ISD process is a deliverable. Furthermore, the case is stated that not only are all of these deliverables things that can be evaluated, but also that a system of evaluation which calls for all deliverables to be evaluated is parsimonious of effort in the long run and serves as a systemic quality control program. The term introduced here to mean evaluating all project deliverables as they are completed, is front-to-back formative evaluation. To illustrate the applicability of the proposed concept as a prescriptive theory, a graphic linear ISD model is presented which is an elaboration of the widely used Dick & Carey Model. The expanded model, called the Braden Formative Evaluation Model, clearly depicts the relationship between formative evaluation activities and instructional design and development procedures. Predictive evaluation is defined and distinguished from formative evaluation, with the suggestion that its role in instructional design needs to be fully elaborated.

Formative Evaluation: A Revised Descriptive Theory and a Prescriptive Model

The Trend Toward Formative Process Evaluation

In the past decade or so, but particularly in the past five years, this author and several others have moved away from a simple prescription for end-of-project formative product evaluation and toward more complex prescriptions for expanded formative evaluation as part of the ISD process (Braden 1987, 1991; Carey & Carey, 1980; Flagg, 1990; Nervig, 1990; Reeves, 1989; Van Patten, 1989). At the same time, however, there has been a continuation of highly respectable material written which has clung to the narrower conception of the role of formative evaluation in instructional design and development (e.g., Dick & Carey, 1990, 1991; Russsell & Blake, 1988).

A classic contribution to the unfolding of a broader definition of formative evaluation is Barbara Flagg's *Formative Evaluation for Educational Technologies* (1990). Although Flagg did not offer a model for process-oriented formative evaluation *per se*, she did identify four phases of formative evaluation. Taken together these phases represent a front-to-back implementation of formative evaluation methods. Flagg's phases were presented in the following format:

Phases of Program Development	Phases of Evaluation
Planning	Needs Assessment
Design	Pre-production Formative Evaluation
Production	Production Formative Evaluation
Implementation	Implementation Formative Evaluation (Flagg, 1990, p. 35.)

The thought that all of us evaluate everything we do as we go along is so logical as to be considered fundamental. In that sense, suggesting that ID practitioners evaluate the output of each major step or activity as they proceed through instructional design and development could be interpreted as trivial, gratuitous, or even insulting. Therefore, the suggestion of this paper goes further, contending that casual consideration of the quality of work-in-progress is not the same thing as systematic, thorough, on-going formative evaluation. That said, the only thing new about front-to-back formative evaluation as a part of instructional design and development is a set of implementation ideas: (1) Steps should be added to ISD models to assure that formative evaluation is both systematic and systemic, and (2) The concept of **formal** front-to-back formative evaluation must be moved from the concept stage into everyday practice.

Models

A model for the evaluation of instructional development must, necessarily, be based upon the instructional systems design (ISD) process itself. Instructional systems design models are not in short supply. Twenty years ago Stamas (1972) wrote an occasional paper for the Division of Instructional Development that compared 23 ISD models. More recently, Gustafson (1991) considered 33 models before selecting a dozen to review in the second edition of a *Survey of Instructional Development Models*. In between times there have been literally dozens of models proposed. In a single article Andrews and Goodson (1980) analyzed 40 instructional design models selected from over 60 they had identified. Even with all of this outpouring of models—some descriptive, some prescriptive, some astute, some inane—only a few have gained more than passing attention because most of the models tend to be similar to each other.

Gropper (1977) compiled a list of 10 generally agreed upon steps found in most ISD models. Andrews and Goodson extended that list to 14 items, but conceded that all four additions were actually components of a single process, needs assessment. Thus a generally agreed upon list with 11 steps would include tasks associated with needs assessment, specifying outcomes, goal/task analysis, sequencing goals/ objectives, identifying learner attributes, formulation of strategies, media selection, materials development, tryout/revision, and install/maintain. Notice that the term evaluation does not appear. In actuality, many of the models upon which the consensus steps were based included the term evaluation rather than tryout. This author holds that the step "install/maintain" is a post-design event and therefore isn't really an ISD step—which would leave us with 10 design steps as building blocks if we were inclined to create an all inclusive generic ISD model.

The conception of a systems process composed of a series of steps, whether they are those listed above or others, lends itself to a flow chart display. The principle model-design elements for flow charting are the box and the arrow. As a result, most ISD models are schematically some sort of elaboration upon the basic arrow-box-arrow design of the basic input-process-output model (see Figure 1).

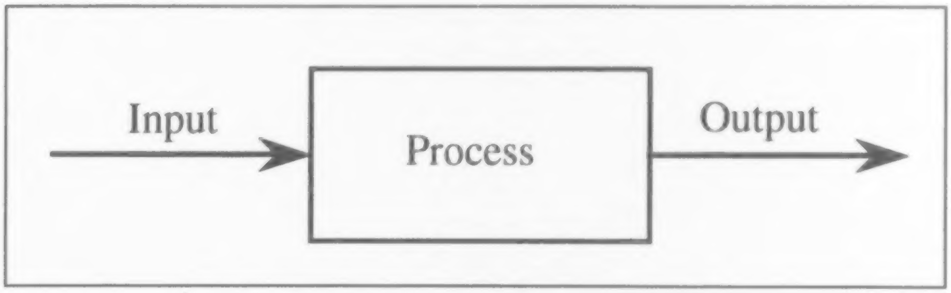

Figure 1. Basic Input-Process-Output Model

A common characteristic of even the earlier instructional systems models has been the feedback loop (e.g., Banathy, 1968). By applying a feedback loop to the basic input-process-output model we get something that looks like Figure 2.

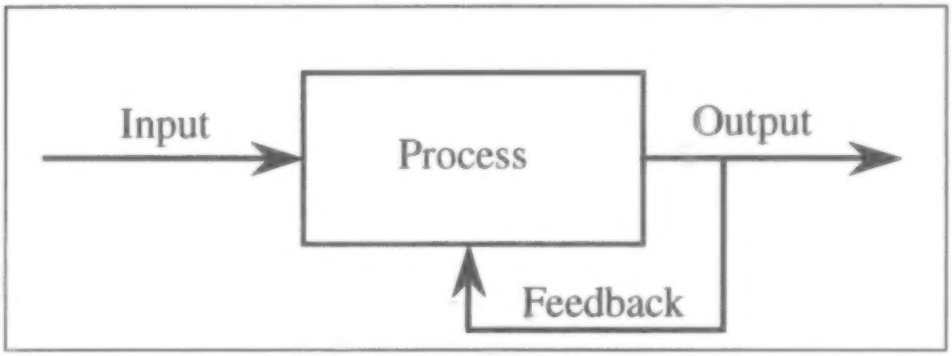

Figure 2. Basic Feedback Model

Next, if we consider that the source of any useful data to be fed back in the feedback loop is likely to be some form of evaluation of the output, we could construct a more accurate depiction of the basic feedback model. For example we might designate a circle with the letters F.E. inside to represent formative evaluation of the process output. The graphical result would look something like Figure 3.

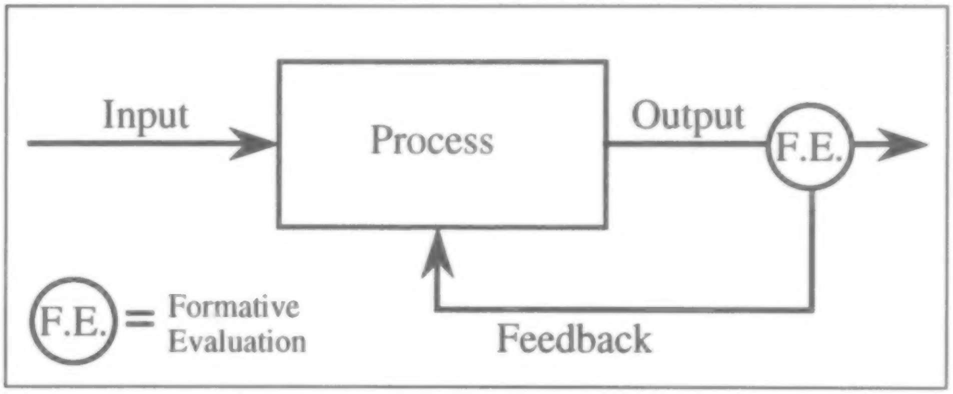

Figure 3. Basic Evaluation Feedback Model

Skipping ahead to a more complex graphic display of a procedure, we might wish to show several separate steps—as, for example, in a generic instructional systems model. We must bear in mind, however, that every box in a flowchart model represents its own sub-process. Thus, if we chose to do so we could display each traditional ISD macro-step as its own multiple step box-and-arrow model, showing all of the mini-steps. Complete with feedback loop, the diagrammatic features would be similar to Figure 4. Note that the input arrow is implied rather than shown and that output has been renamed "implement."

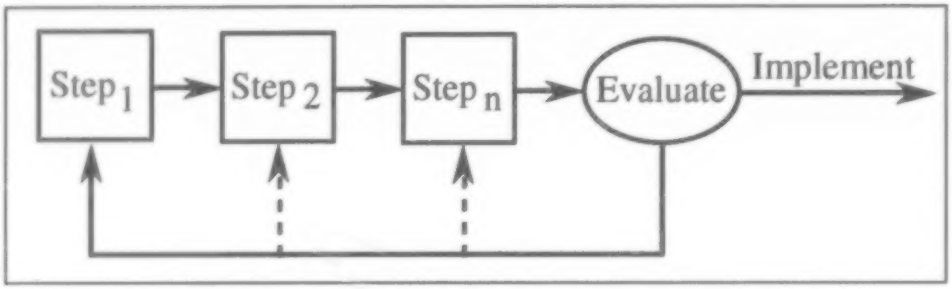

Figure 4. Diagram of a Multi-Step Generic ISD Model

Figure 5 illustrates what happens to our diagram when we consider that the ntire instructional design procedure is nothing more than a process which could be represented in a single box. We have a clear example of a self correcting process wherein the element of evaluation for feedback is the critical part of the process which dictates any needed revision.

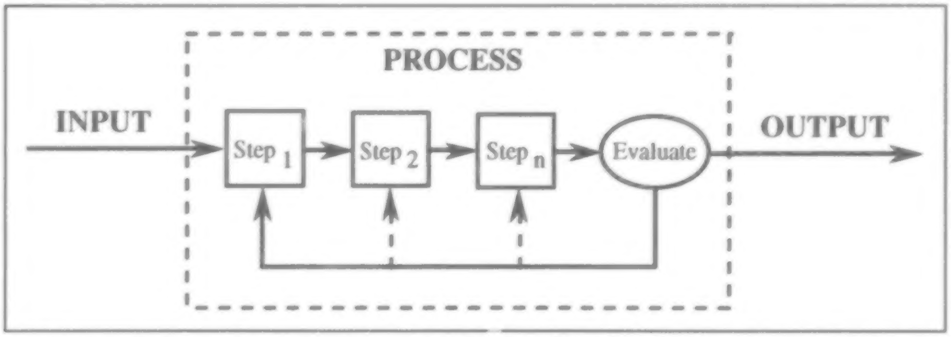

Figure 5. Input-Process-Output Model Combined with Generic ISD Model

An ISD Model That Is Also a Formative Evaluation Model

Front-to-Back Formative Evaluation

A major purpose of this paper is to propose an ISD model that is also an evaluation model. In simple terms, the key to the model is that each step results in one or more deliverables and that each deliverable is formatively evaluated and revised as necessary before proceeding to the next step. This concept of front-to back formative evaluation has been used successfully by the author in practice and in his classroom for several years (Braden, 1987). The ISD model which was proposed by Van Patten (1989) also calls for front-to-back formative evaluation, and is also based upon the premise that each deliverable should be specified, created, then formatively evaluated. Earlier, Carey & Carey (1980) suggested a general set of formative evaluation questions the answers to which would assist local selection committees in reviewing instructional materials. The Carey & Carey approach was comprehensive, dealing with all aspects of the instructional design process, but they did not suggest that each sub-process (step) be formatively evaluated before proceeding to the next step.

A Symbol for Formative Evaluation of Deliverables

A definition of the symbolic notation used by this author in a front-to-back formative evaluation model is critical to a full understanding of that model and its implications. Specifically, it is essential that readers know the meaning of a symbol made up of a rectangle with an embedded circle containing the letters F.E. In short, it means "formative evaluation is the last sub-step performed in that step of the model." Thus a box with an embedded F.E circle, although symbolically different, is identical in meaning to the box—arrow—F.E.Circle—feedback-loop diagram shown in Figure 3. *In essence the new symbol represents any process or procedure that has a built-in evaluation and revision provision,* ***making it self-correcting*** (see Figure 6).

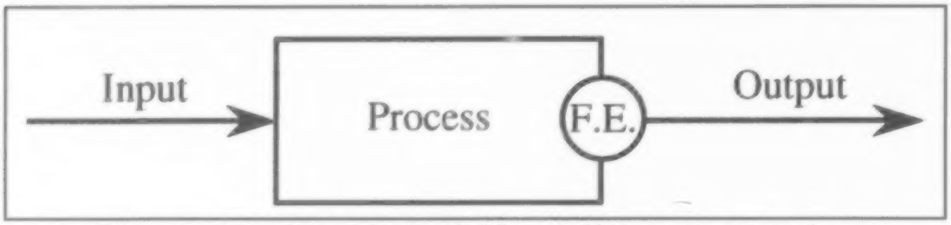

Figure 6. A New Icon: The Symbol for a Self-Correcting Procedure

The Elaborated Instructional Design Model

Revising the Structure of the Consensus ISD Model

Although the proliferation of instructional design models has slowed down from the frantic pace of the 1970's (Gustafson, 1991), between the "not invented here" syndrome and the insatiable need of certain personality types to tweak and polish, we can expect several new models each year. As Shrock has observed, during the 1970's, "experience with instructional development was revealing problems, and important and permanent modifications of the earlier models were made. One of the most important was the addition of needs assessment to the collection of steps that defined the process." (1991, p. 17.)

Three other important modifications could become generally accepted during the 1990's: elaboration of the step labeled "strategies" (Leshin, Pollock & Reigeluth, 1992), accommodation of the concurrent design of instruction and motivation (Keller, 1979, 1983), and integration of front-to-back formative evaluation (Braden, 1987; Van Patten, 1989). Adding motivation to the elaborated model and expanding the strategies component—while called for—are not the purposes of this paper. So those addenda will be left to another time.

Adding Front-to-Back Formative Evaluation Points to the ISD Model.

Elaborating the model with front-to-back formative evaluation is on the current agenda, and Figures 7a and 7b graphically illustrate how easily the modification can be made. To facilitate discussion, the elaborated model (Figure 7b.) has been labeled the Braden Model to distinguish it from its obvious predecessor, the Dick & Carey Model (Figure. 7.a.). The Dick & Carey Model is one of the three or four best known ISD models, and the text in which it is featured is now in a third edition (Dick &

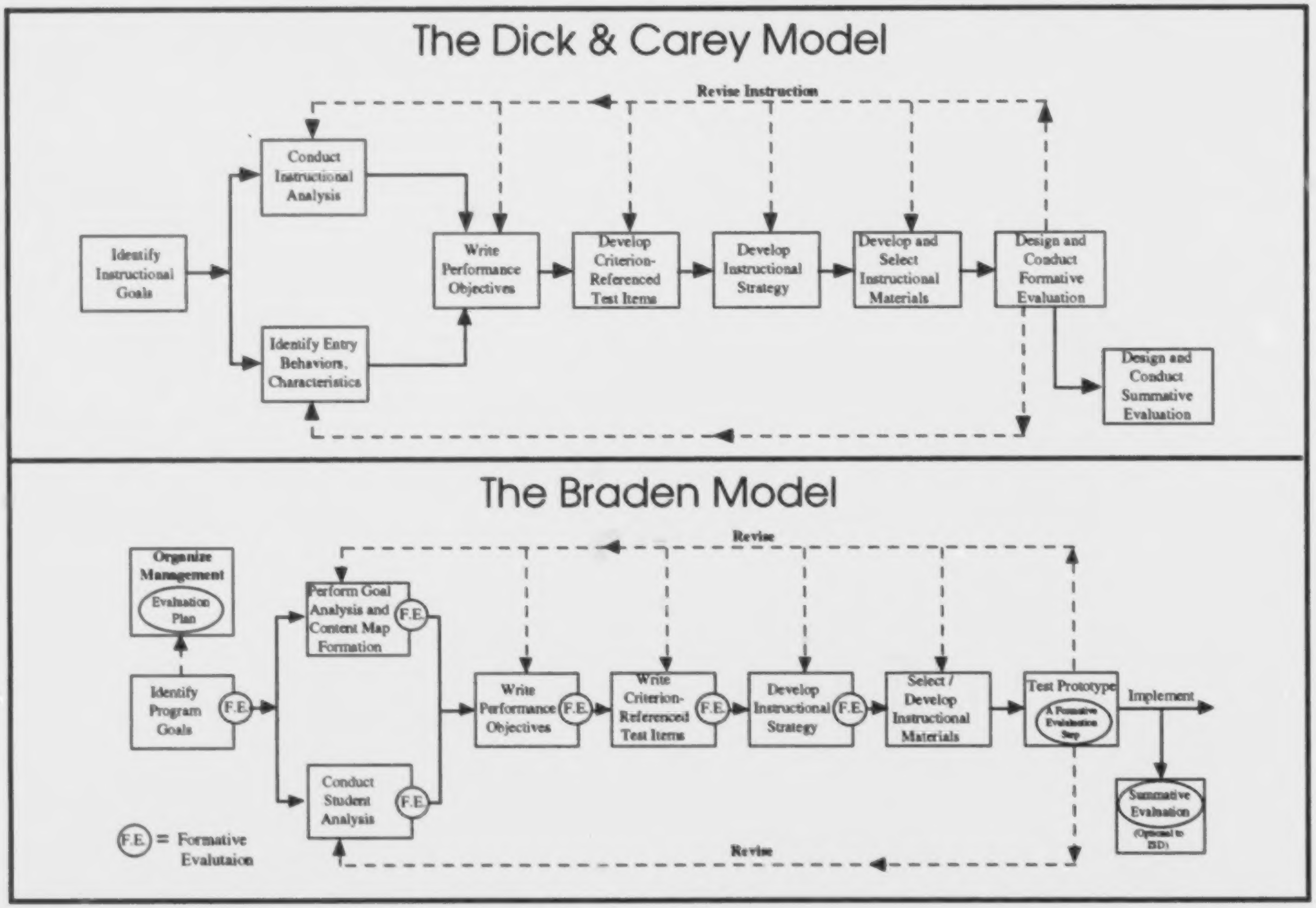
The Dick & Carey Model
Revise Instruction
Identify Instructional Goals
Conduct Instructional Analysis
Identify Entry Behaviors, Characteristics
Write Performance Objectives
Develop Criterion-Referenced Test Items
Develop Instructional Strategy
Develop and Select Instructional Materials
Design and Conduct Formative Evaluation
Design and Conduct Summative Evaluation
The Braden Model
Revise
Organize Management
Evaluation Plan
Identify Program Goals
F.E.
Perform Goal Analysis and Content Map Formation
Conduct Student Analysis
Write Performance Objectives
Write Criterion-Referenced Test Items
Develop Instructional Strategy
Select / Develop Instructional Materials
Test Prototype
A Formative Evaluation Step
Implement
Summative Evaluation
(Optional to ISD)
Revise
F.E. = Formative Evalutaion

Figure 7a. (left) The Dick & CArey Systems Approach Model for Designing Instruction. © 1990, Walter Dick and Lou Carey.

Figure 7b. (right) The Braden Formative Evaluation Model. © 1991

Carey, 1990). That particular model was selected for elaboration because of its recognition value. The original version of the elaborated Dick & Carey Model was first shown at the 1987 DID luncheon.

In its present form the Braden Model departs from the Dick & Carey Model in three significant ways. First, and most obvious, the "F.E." nodes have been added. Second, an "organize management" box has been added which includes writing the evaluation plan. Since management functions are apart from the design process, that box is displayed "off line." Third, the step which Dick and Carey label "Design and Conduct Formative Evaluation" has been more appropriately identified as "Conduct Prototype Test." That label was chosen in preference to "Tryout" because it was felt that "prototype" emphasized the formative nature of the instructional materials until after they "pass" the test.

- Formative Evaluation (F.E.) Nodes

A characteristic of each box in the Dick & Carey Model is that the box represents a discrete sub-process. An argument could be made that some or all of the sub-processes could be divided and displayed as two or more boxes each, but that is irrelevant. What matters is that the end of every sub-process shown is distinct, and is observable in the form of a tangible deliverable(s). Two factors were considered in adding these nodes: (1) Anything that is tangible can be evaluated. (2) In a linear process where linearity is a required condition, each step is a prerequisite for the one(s) that follow. In effect, the deliverable or output of step one is all or part of the input of step two.

The most radical aspect of the front-to-back formative evaluation procedure implied in the F.E. nodes is that there is a philosophical departure from the developmental testing of instruction (not the procedure for designing that instruction.) Walter Dick, the most frequently cited author on the subject of formative evaluation of instructional design, set a narrow focus for the field when he wrote, "These developmental testing procedures now tend to be considered as the operational definition of formative evaluation..." (Dick, 1980, p.3.) In terms of the types of evaluation defined by Stuffelbeam (1973), that operational definition limits formative evaluation to product evaluation. Inherent in the step-at-a-time evaluation scheme of the Braden Model is the opportunity to utilize evaluation data for the purpose of making appropriate alterations to the process. *[In fairness to Dick, he was absolutely correct. A limited concept of formative evaluation had been generally accepted. The tone was likely set by Bloom, Hastings and Madaus who authored a large format book of over 900 pages on formative and summative evaluation. Less than two pages of that tome were devoted to the prospect of using formative evaluation as the basis of altering the process and for the companion purpose of process quality control (see Bloom, Hastings, and Madaus, 1971, pp. 135-6.)]*

- Organize Management

Project management has been a concern of instructional designers for two decades. One of the nine steps in the widely disseminated Instructional Development Institute (IDI) Model is "Organize Management" (N.M.S.I., 1971). In addition to logistics planning, time allocation, budgeting, and so forth, a critical management consideration is quality control. The heart of quality control is evaluation, and flaws caught early avoid compounding of errors which is desirable because simple errors are more easily remedied. Greer has recently brought new light to this often ignored aspect of instructional design. In a chapter about ID project management (Greer, 1991), he listed eight "inspection points" in the typical ID project. He followed that work with a textbook (Greer, 1992) on the same subject which included his version of an ISD model. In the Greer Model, phase I is "Project Planning," which coincides closely with the front-of-the-model location given to management planning in the Braden Formative Evaluation Model.

- Conduct Prototype Test

Except for the change in terminology, there is no difference in what happens at this step in the Dick & Carey Model and in the Braden Model. Dick and Carey (1990, 1991) have done a splendid job of explaining the purposes and techniques of formative product evaluation as it applies to the instructional materials resulting from an instructional design project. Unquestionably their description of what is to occur at this step is a formative evaluation activity. However, the activity at that juncture is only a part of the total formative evaluation of the project, and therefore deserves a more accurate label: tryout or prototype test.

Imposing Front-to-Back Formative Evaluation upon Existing ISD Models

Not every ISD model can readily be adapted to incorporate front-to-back formative evaluation. However the majority or ISD models can be so adapted with ease. The requirements for applying the f-t-b formative evaluation component to an existing ISD model are:

1. The model should be linear. [Non-linear models might benefit also, but a major rationale for adding f-t-b F.E. would be lost.]

2. The model should be a prescriptive model for, not a descriptive model of.

[*e.g.*, a graphic model for is the Dick & Carey Model (1990) which prescribes a sequence of design activities.]

[*e.g.*, a textual, non-graphic model of is Tennyson's Instructional Design Model (1990) which describes the linkage between cognitive learning theory and instructional prescriptions.]

[*e.g.*, a graphic model of is Tennyson's Model of Cognitive System for Educational Learning Theory (1992), which uses boxes and arrows, but uses them more to describe interactions than to prescribe linear function.]

How it Works

A fair question at this point would be, "OK, just what do you **do** in a front-to-back formative evaluation?" A short answer would be that at every F.E. node in the process you ask questions of consistency and adequacy. (For the origin of that method of assessing step-to-step quality, see Reigeluth's 1980 article on The Instructional Quality Profile.) In reality the full answer is much more complex. As with any evaluation effort, the exact methods depend upon the nature of the data we wish to collect. At the highest level of generalization, let us theorize how we might perform what is called for at an F.E. node. First, we would start with a deliverable (a product). Next we would ask questions of consistency such as: Is it appropriate? Does it reflect the input from the previous step? Is it consistent with the project goals, the performance objectives, etc.? We would then gather whatever data we deemed necessary to answer those questions to our satisfaction. Then, we would ask questions of adequacy such as: Is this sufficient? Will this deliverable be useable as the input for the next step in the ID process? Does this product reflect all of the elements of the input, *i.e.*, is it complete? Again we would choose the data gathering technique which best matched the circumstances and the nature of the information sought. With all of the data in hand we would assess the quality and ongoing utility of the deliverable. In the event that the evidence indicated that the deliverable was either inappropriate or insufficient, we would pose a different kind of question: What caused the flaw or inadequacy? The search for that answer invites process evaluation. We want to know what we did wrong, what we did poorly. If no process errors are detected, we would then loop back to the previous step to re-examine its output.

The Time Factor

Another fair question would be, "Isn't adding all of that routine checking of the deliverables too time consuming?" Again a short answer would be that if you never make mistakes, it is too time consuming. Otherwise, catching flaws and errors early tends to save time. Once you have prepared a set of checklists, routines, and questions to be used at each node, you will find that there is a high level of transfer of those tools to your next project. Armed with a set of evaluation instruments that need little or no revision, the task requires much less of your time.

Looking at the other addition that was made to the original Dick & Carey Model, a parallel question might be asked about the time consumed in the writing of an evaluation plan. The short answer to that is to be found in the management value of the evaluation plan itself. Just knowing that everything will be put to the test establishes a mind set for high standards and excellence. Knowing that the building blocks of the present ID event have been sharply scrutinized adds confidence that the project is on track. Detection of problems that require remediation provides early warning that the time line for the project is in jeopardy, allowing the designer more time to renegotiate delivery dates or to bring more resources to bear on the project. The data gathering also has implications for matters of personnel management, budget monitoring, avoidance of political problems, and all kinds of other factors where information might be important to decision-making. Is the time spent worth all of these benefits? In most cases, yes. Besides, one evaluation plan tends to resemble all others. Just as there is a carryover of tools for the F.E. of deliverables, there is a carryover from evaluation plan to evaluation plan. After you have once assembled a plan that you like, large portions of it can be used as "boiler plate" in the writing of your next evaluation plan.

Being Consistent with Stuffelbeam's CIPP Model

The literature of evaluation is permeated with references to Stuffelbeam's CIPP Model (Stuffelbeam, 1973). Perhaps the most significant characteristic of CIPP is that it makes provision for holistic evaluation. Its elements are systems oriented, structured to accommodate universal evaluation needs. The tenets of CIPP are so widely accepted, so firmly rooted that they cannot be ignored. With that in mind, a reasonable course of action would be to use CIPP as a litmus test for any serious proposal of an evaluation system. Then, assuming that we consider the amount and nature of the evaluation encompassed within the instructional design process to constitute "an evaluation system," we can [should?] ask, "How does this system stack up in terms of CIPP?

- Context is evaluated in needs assessment when we evaluate the status quo. Flagg (1990) adopted the term needs assessment as the label for the first of her four phases of formative evaluation. In the model offered here, the evaluation of goals implies a consideration of whether it is appropriate to plan to employ instruction as the appropriate means to improve the status quo (the context).

- Input is evaluated in both needs assessment and during student analysis when we evaluate the students' entry competencies. Additionally, there is an element of input evaluation in what we do while assessing subject content during instructional goal/task analysis.

- Process evaluation is not prescribed in the vast majority of ISD models. Front-to-back F.E. as proposed herein does prescribe process evaluation. (Formative evaluation of the deliverable of any given ISD process step is product evaluation initially. However, as soon as a flaw in the product is determined, the procedure shifts to an evaluation of the process which permitted the flaw to occur.) **None of the ISD models reviewed in Gustafson (1991), Stamas (1970), Gropper (1977), or elsewhere include a step(s) for process evaluation.** Except for the model proposed here, only the Van Patten

Model, and the Flagg phases (both non-graphic) provide for process evaluation. Yet Reeves (1989, p. 164.) recognized that process evaluation was needed: "Obviously, prototype products will be a major focus of formative evaluation during an instructional design project, but there should be an equal emphasis on collecting formative evaluation to improve the overall instructional design **process**..." [Emphasis mine.]

- Product evaluation describes what happens in the ISD tryout step. Although referred to in the Dick & Carey and several other models as **formative evaluation**, and in many models simply as **evaluation**, the term **formative product evaluation** more accurately describes the tryout process. The term **prototype test**, as used in the model offered in this paper, is also a product evaluation label that accurately describes the procedure. As mentioned in the discussion of process evaluation, the F.E. nodes in the Braden Model are product evaluation points until a deficiency or product flaw is detected.

Predictive Evaluation

The terms formative and summative evaluation have been around long enough now that they are part of the vocabulary of every instructional designer and developer. In a black or white world those two forms of evaluation would represent the entire palette of evaluation choices. Things are not as simple as black and white, however, and even though our palette isn't a full spectrum rainbow, it does contain some tints and shades. Most notable, of course, is Needs Assessment which fits into neither the formative crate nor the summative barrel.

One way to view the kinds of evaluation that we need in ISD is to consider the underlying *purposes* of each.

- We use **discrepancy analysis evaluation** (including needs assessment) for establishing parameters during goal setting and some forms of decision making. Any decision that requires a choice will benefit from this kind of evaluation of the things that might be chosen.

- We use **formative evaluation** for quality control. Either the process or the associated products can be the focus of formative evaluation.

- We use **summative evaluation** for accountability purposes. Sometimes we perform summative evaluation just to satisfy our curiosity about how effective a product has been, but more likely needs for summative evaluation are linked to costs vs. benefits analysis and to decisions about program funding or survival. Summative evaluation is something that happens to instructional design, not something that is a part of it.

- And then there is that other kind of evaluation — the kind we use to improve our chances of being correct when we make a guess. For lack of a better term, let's call this kind of evaluation "**predictive evaluation**."

Instructional designers do a lot of predictive evaluating when they organize the management of projects. Budget estimation, time estimation, guesses about materials that will be used and the skills that will be required are all imprecise activities. Intuitively designers attempt to improve their guessing average by basing their estimates upon good, analyzed information. The art of forecasting will always contain a luck factor, but luck can be reduced by evaluating the options open to us. A method to assist us with the evaluative aspects of estimation would greatly benefit the instructional design and development field.

We are likely soon to find that predictive evaluation has become as much a part of ISD as formative evaluation —but in the form of an expert system rather than as a box in a model. If not, we will need to accommodate it in our evaluation models, if not in the ISD models themselves.

REFERENCES

Andrews, D. H. and Goodson, L. A. (1980). A comparative analysis of instructional design. *Journal of Instructional Development*, *3*(4) [this seminal article has been reprinted in Anglin]

Anglin, G.J., ed. (1991). *Instructional technology past present and future*. Englewood, CO: Libraries Unlimited, Inc.

Banathy, B.H. (1968). *Instructional Systems*. Palo Alto, CA: Fearon Publishers

Bloom, B.S., Hastings, J.T., and Madaus, G.F. (1971). *Handbook on formative and summative evaluation of student learning*. New York: McGraw-Hill Book Company.

Braden, R. A. (1987). Instructional design: Forms of formative evaluation. *Educational Technology*, *27*(1), 33-34.

Braden, R. A. (1991). Instructional design: Some revised thoughts about revision. *Educational Technology*, *31*(8), 32-33.

Carey, J.O. and Carey, L.M. (1980) Using formative evaluation for the selection of instructional materials. *Journal of Instructional Development*, *3*(3) 12-18.

Dick, W. and Carey, L.M. (1990). *The systematic design of instruction* (3rd ed.). Glenview, IL: Scott, Foresman.

Dick, W. and Carey L.M. (1991). Formative evaluation. In L.J. Briggs, K.L. Gustafson, and M.H. Tillman (eds.). *Instructional design: Principles and applications* (Second Edition). Englewood Cliffs, NJ: Educational Technology Publications.

Flagg, B.N. (1990). *Formative evaluation for educational technologies*. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Geer, M. (1991). Organizing and managing the ID process. In L.J. Briggs, K.L. Gustafson, and M.H. Tillman (eds.) *Instructional Design: Principles and applications*. Englewood Cliffs, NJ: Educational Technology Publications.

Geer, M. (1992). *ID project management: Tools and techniques for instructional designers and developers*. Englewood Cliffs, NJ: Educational Technology Publications.

Gropper, G.L. (1977) On gaining acceptance for instructional design in a university setting. *Educational Technology*, *17*(11) 7-12.

Gustafson, K.L. (1991). *Survey of instructional development models*. Syracuse, NY: ERIC Clearinghouse on Information Resources.

Keller, J. (1979). Motivation and instructional design: A theoretical perspective. *Journal of Instructional Development*, *2*(4), 26-34.

Keller, J. (1983). Motivational design of instruction. In C.M. Reigeluth (ed.), *Instructional- design theories and models*. Hillsdale, NJ: Lawrence Erlbaum.

Nervig, N.N. (1990). Instructional systems development: A reconstructed ISD model. *Educational Technology*, *30*(11), 40-46.

Reeves, T.C. (1989). The role, methods, and worth of evaluation in instructional design. In K.A. Johnson and L.J. Foa (eds.), *Instructional design: New alternatives for effective education and training*. New York: Macmillan Publishing Company.

Reigeluth, C.M. (1980). The instructional quality profile: Training teachers to teach effectively. *Educational Technology*, *3*(20), 7-16.

Russell, J.D. and Blake, B.L. (1988). Formative and summative evaluation of instructional products and learners. *Educational Technology*, *28*(9), 22-28

Shrock, S.A. (1991). A brief history of instructional development. In Gary J. Anglin, *Instructional technology past present and future*. Englewood, CO: Libraries Unlimited, Inc.

Stamas, S. (1972). A descriptive study of a synthesized model, reporting its effectiveness, efficiency, and cognitive affective influence of the developmental process on a client. *Dissertation Abstracts International*, 34. (University Microfilms No. 74-6139)

Stufflebeam, D.L. (1973). Toward a science of educational evaluation. *In Evaluation of education. Educational technology review series, no.11*, 20-47. Englewood Cliffs, NJ: Educational Technology Publications.

Tennyson, R.D. (1990). Instructional design theory: Advancements from cognitive science and instructional technology. In M.R. Simonson and C. Hargrave (eds.), *Proceedings of selected research paper presentations at the 1990 annual convention of the Association for Educational Communications and Technology*. Ames, IA: AECT.

Tennyson, R.D. (1992). An educational learning theory for instructional design. *Educational Technology 31*(1), 36-41.

Van Patten, J. (1989). What is instructional design? In K.A. Johnson and L.J. Foa (eds.), *Instructional design: New alternatives for effective education and training*. New York: Macmillan Publishing Company.

Title:

Instructional Design Practices and Teacher Planning Routines

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Abstract

The hypothesis that the planning activities of classroom teachers correlate with the practices of instructional design professionals is explored within the context of this study. Classroom teachers participated in a survey which requested information regarding their planning routines. A 35-item two part questionnaire was used as the data collection instrument. Sixty-one public school teachers reported on their actions when planning to teach on a daily basis, and indicated such demographic information as typical class size, number of years teaching, grade level and educational background. Results indicate that a correlation exits between teacher planning activities and instructional design practices, and that such a relationship is influenced by the subject taught.

Preliminary investigations of teachers as instructional designers (Branch, 1986; Branch, Darwazeh & El-Hindi, 1991) suggest there is a false assumption that teachers do not engage in instructional design practices. Further, instructional design jargon tends to inhibit communication between instructional design professionals and public school teachers. In addition, it appears that certain teacher profiles may enhance the potential for teachers to practice instructional design or that the contextual factors which encompass public school environments make the use of traditional instructional design models impractical.

This called for a shift of the focus on teachers as instructional designers away from the perspective of the instructional designer and more toward the perspective of the public school classroom teacher. In order to accomplish this there was a need to identify teacher planning practices and instructional design practices that are essentially similar in purpose and orientation, but different in execution. This also prompted a need for identifying correlations between the potential for teachers to practice instructional design and contextual factors such as number of years teaching, class size and education level of the teacher.

This is a report of an investigation which sought to answer the fundamental question: Do teachers practice instructional design? from the perspective of public school teachers. This study was conducted based on teacher planning research conducted during the past decade which suggests that teachers actively develop routines which are executed in the school environment (Applefield & Earle, 1990; Earle, 1985; Kerr, 1981; Sherman, 1978; Zahorik, 1975). The process for developing teacher planning routines has evolved from experienced educational practices as well as from current teaching theories and learning theories. Instructional designers systematically select, adapt, develop and refine a wide variety of instructional products (Martin, 1984). The process of instructional design evolved from a conceptual amalgam of general systems theory (Banathy, 1968; 1973), the application of technology to educational methodology (Chisholm & Ely, 1976), and the psychology of learning (Gagne, 1977). A review of instructional design procedures and teacher planning routines literature (Andrews & Goodson, 1990; Briggs & Wager, 1981; Dick & Carey 1990; Gagne, Briggs, & Wager 1992; Merrill 1983; Merrill, Reigeluth, & Faust 1979; Pratt, 1980; Reigeluth, & Stein, 1983; Earle, 1985; Yinger, 1979; Zahorik, 1975) reveals that teachers and instructional designers are involved in similar basic activities such as: planning, designing lesson plans, designing unit plans, designing test items, stating objectives, managing, evaluating, and consulting. Instructional designers tend to focus on selecting instructional materials, analyzing content, sequencing content, and decision-making; whereas, teachers focus primarily on the implementation and evaluation of instruction.

Because teachers are at the "front line" in the educational process (Earle, 1985), understanding the logic of their actions is important as educators attempt to increase the efficiency of the educational process. Beilby (1974) emphasized the importance of instructional development for teachers by questioning the view that the instructional design process must be managed by the education specialist. Beilby (1974) presented a strong case for teacher involvement in instructional design and stressed the need for training teachers for the instructional designer role. In the past teachers have developed instructional design skills through 1) the pre-service curriculum, 2) in-service training, and 3) working with an instructional designer to improve present courses. While the second two needs are important, it is the first need, the pre-service teacher preparation curriculum, this project addresses by developing an inventory of teacher planning information that focuses on instructional designer competencies which might be incorporated into teacher preparation programs.

The rationale for this investigation is that successful teachers engage in similar actions to those associated with instructional design when preparing to teach. But, does this mean teachers are instructional designers? According to Kerr (1981): "Teachers are and are not instructional designers. Most teachers have not had formal training in the procedures commonly used by instructional designers: many find it difficult to shift their thinking into instructional design (ID) patterns when they are asked to do so as part of a course or workshop" (p. 364). This can be partly attributed to the less than positive attitude of some teachers toward the use of instructional design models out of fear that a systematic approach restricts creativity (Branch, 1986). Instructional design ideology adopts the position that a systems approach promotes creativity by increasing the number of alternatives generated and by testing instructional options prior to implementation.

Traditionally, educators and instructors have determined the major elements of the instructional process to be students, teachers, and curriculum. Since 1970, however, rapid technological advances have necessitated bringing the instructional designer into the core of the instructional process. The systematic design of instruction is usually considered to be the role of the instructional designer. There is a trend among instructional design professionals however, to focus attention on the need for preparing and training public school teachers for the instructional designer's role (Applefield & Earle, 1990; Dick & Reiser, 1989; Earle, 1985).

The contention is that there is a correlation between teacher planning routines and what instructional designers do when designing instruction. In order to support this belief, a systematic investigation is being conducted to determine the extent of this correlation.

Instructional Episode

Instruction, as subsumed under the concept of curriculum (Reigeluth, 1983), is the intervention that occurs during a content-media-teacher interaction where the expressed goal is to facilitate the progression of a learner from point A to point B along the educational continuum. An accurate assessment of learner characteristics, a thorough analysis of content attributes, and the potential of the teacher to facilitate the learning process are the independent variables within the instructional environment that the designer or teacher attempts to manipulate in order to create or improve instruction. This specific period of interaction is hereafter referred to as the instructional episode.

The instructional episode serves as the formal educational vehicle that enables the learner to construct, or reconstruct, personal understandings, values, and beliefs. Instruction is complex because it occurs within a paradigm where each participating entity is within itself complex. Interaction between the Learner, the Content, the Media, the Teacher Function, and the Context within which learning is to occur during a given period of Time form the instructional episode (CMT paradigm). Considering all the interrelationships of the instructional episode causes the complexity of the learning process to increase exponentially. Yet, it is within this paradigm that all instruction occurs (Figure 1).

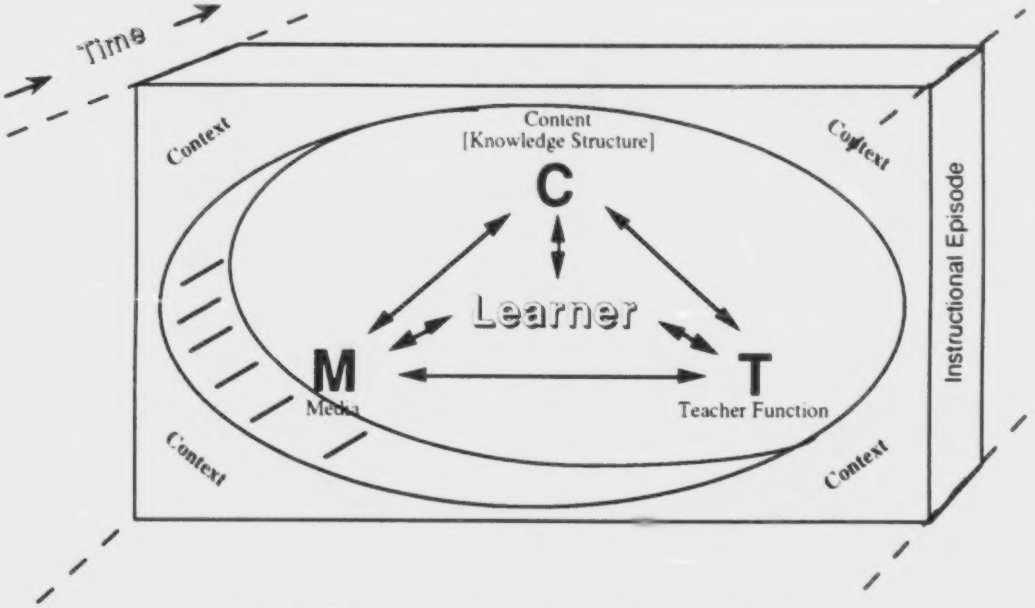

Figure 1. The complex environment in which learning occurs.

Within the CMT paradigm, the **learner** is the focus of instruction. Learners as individuals, bring multiple expectations, goals and diverse values to the classroom that affect how they interact during an instructional episode, and ultimately, how they learn. It is also important for instruction to account for the individual differences within the wider learner audience.

Content as a body of knowledge may be static or dynamic, but it is not a collection of unorganized facts existing in relative isolation one from the other (West, Fensham & Gerrad, 1985). Rather, there are certain orderly structures inherent within subject matter knowledge (Reigeluth, Merrill & Bunderson, 1978; Wilson, 1985). Information is not discrete, isolated bits of knowledge, but exists within an organized structure (Eylon & Reif, 1984). Such structures reflect the interconnections or interrelationships among the facts, concepts, and principles that make up subject matter knowledge (Anderson, 1983). Representations of information and interrelationships among information can be called knowledge structures (Hannum, 1988).

Media is the vehicle by which teachers stimulate, motivate, illustrate, provide concrete experiences, and direct attention. Mediated instruction which is related to the personal experiences of the learner will assist in building upon her or his prior knowledge and promote achievement, whereas messages communicated by various forms of instructional media that is foreign to the experiences of a student or offensive to the values of a student tends to inhibit learning.

Generally, the **teacher** functions as decision maker regarding what will be taught, when it will be taught, and how it will be taught. The teacher is often the primary information source unless the teacher functions solely as a facilitator of information. As facilitator, the teacher arranges classroom interactions so as to motivate learners and to guide the learner to different ways of knowing. Teachers direct learner actions, monitor progress, and manage the implementation of instruction.

The **context** within which instruction occurs directly and indirectly influences all decisions regarding any instructional episode. Instruction does not occur in a vacuum and failing to acknowledge such has a potential for a dangerous misunderstanding of the complexity of learning environments. The instructional context includes all the conditions which designers and teachers should consider in some regard to enhance learning. Certain contextual arrangements can be manipulated by designers and teachers while other contextual arrangements are beyond the realm of manipulation by either the designer or the teacher.

Learner achievement of prespecified outcomes depends on the chosen instructional strategy for a predetermined amount of **time**, such as during a class period or field experience. An instructional strategy will vary in effectiveness depending on the allotted time. Moreover, the quality of an instructional activity is affected by the amount of time that can be devoted to it. Further, the abilities of individual learners directly influence the amount of time required to achieve specific learning outcomes. Time, context, teacher function, media, content and the learner, interact simultaneously to form the complexities of instruction.

Instructional Design

As a discipline, instructional design is concerned with understanding and improving one aspect of education: the process of instruction (Reigeluth, 1983). Instructional designers have as their principle objective to induce targeted learners to perform in prespecified ways. They achieve results by developing and implementing documented and replicable procedures for organizing the conditions for learning; and by defining and measuring the accomplishments of instructional design in terms of learner performance (Burkman, 1987). The optimum effects of how student learning is facilitated and what actually occurs in the classroom environment determines what is done during the design of instruction which is different from what is done during the development of instruction. In addition, the role of evaluation in instruction and the management of activities associated with all aspects of instruction is conceptually and practically different. For the context of this study, descriptions of design, development, evaluation, and management as outlined in the "Domains of Instructional Technology" (Association for Educational Communications and Technology, in press) are used as a reference. Interpretations of those domains are presented below.

Instructional Design is the planning phase of the instructional creation process. Instructional design is descriptive, such as the presentation of natural or existing interrelationships that constitute a content area. Instructional design is also prescriptive. It recommends organization, or reorganization, of information or a sequence of events based on known learner characteristics, content as a knowledge structure, specific media and their attributes, salient features of the teacher function, educational context, and time available. Design aspects apply systems theory to address the complexity of the variables within the CMT paradigm, and organizes their interactions in intentional ways.

Instructional development is the process of producing from a detailed plan (design) the procedures and media which support an instructional episode. During the development phase, the instructional procedures and media are created and tested based on the performance objectives identified in the design. Instructional strategies prescribed in the design plan, as well as selection strategies and presentation methodologies, are confirmed or revised based on the results of several appropriate iterations of testing throughout the various stages of development. Innovative and traditional technologies are employed to conduct development activities.

Instructional Evaluation is a dynamic process to obtain data about how students learn specific content information under varying instructional conditions. These data are analyzed and synthesized into ways and means that are used for judging the instructional potential of the planned instructional episode. Evaluation data collected during the design and development phases form the basis for revision of instructional strategies and influence choices of instructional media prior to the implementation of an instructional episode. Instructional evaluation initiates, permeates and concludes the instructional design and development process.

Instructional Management is concerned with the supervision of instructional episodes, including pre-episodic and post-episodic activities, as well as the human and financial resources to support an instructional episode. Legislation, governance, monitoring and certification of the instructional design, development, and evaluation processes needs the endorsement of management.

Teachers as Designers

Dick and Carey (1990), and Gagne, Briggs, and Wager (1992), perceived the teachers' role as that of designer of instruction with accompanying roles of implementor and evaluator of instruction. Others have taken the stance that generic instructional design skills have value for the classroom teacher (Applefield & Earle, 1990; Bielby, 1974; Dick & Carey, 1990; Dick & Reiser, 1989). The University of North Carolina at Wilmington, has integrated a two semester instructional design component into their undergraduate teacher education program (Applefield & Earle, 1990). Clearly the roles of classroom teachers are like that of instructional designers. In fact, taking on the role of instructional designer, on the part of public school teachers would have a great influence on the quality of the teachers' professional performance, and hence, on the level of their students' academic achievement (Figure 2).

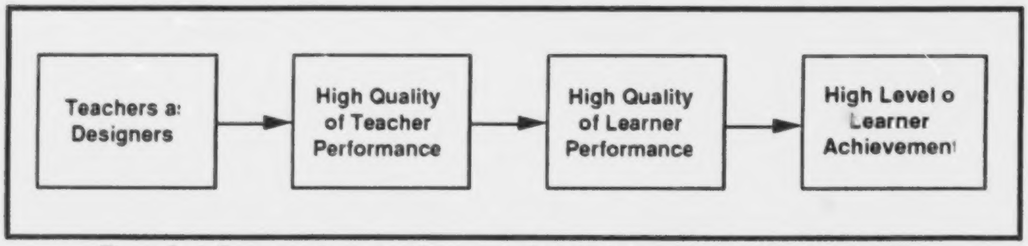
Teachers as Designers
High Quality of Teacher Performance
High Quality of Learner Performance
High Level o Learner Achievemen

Figure 2. Influence on learner achievement when teachers practice instructional design.

The extent that classroom teachers currently engage in the kinds of activities practiced by instructional designers is unclear. The basic assumption is that successful classroom teachers prepare for daily instruction in much the same way that instructional designers create or improve instruction. However, to understand how good teachers express what it is that they "do" is essential to making instructional design meaningful for them. It is inappropriate for the instructional design community to change teacher language, but it is acceptable to clarify and promote good instructional design practices. To state specific instructional design concepts in understandable teacher language is a vital ingredient in research on instructional design. There is a need to find out if teachers understand the concepts of instructional design when asked if they "do" them. This calls for the translation of instructional design practices into teacher language.

Wildman and Burton (1981) indicated that too much time and effort have been spent on developing systematic approaches to the design of instruction without knowing whether these approaches can have widespread utility in the public education sector, or whether the approaches have utility as a device for transforming theoretical statements into practical applications. There is evidence of pre-service teacher success in acquiring and applying principles of learning and instructional design in the public education sector (Earle, 1992; Klein, 1991). However, the reality of the instructional context for public school teachers may require instructional technologists to reconsider the value of instructional design models intended for applications in public school environments.

The purpose of this study was to collect and summarize data that can be used to correlate teacher planning practices and instructional designer practices. The following assumptions were made in order to formulate the research questions: (1) teachers assume routines or patterns when preparing to teach, (2) instructional designers practice mainly planning activities, (3) the abundance of instructional design models are aimed at improving the instructional episode, and (4) instructional design jargon adversely affects teacher perceptions about the value of the systematic approach. Based on these assumptions, the following questions formed the impetus of this study: Is there a correlation between the planning routines of teachers and the actions of instructional designers?, and What contextual factors affect the degree of instructional design practiced by public school teachers?

Methodology

Participants

The participants for this study consisted of 61 public school teachers from the northeast United States. The participants included those currently teaching grades seven through twelve, and represented seven subject areas. The participant group was divided into two selected samples: 1) 41 junior or senior high school teachers from a central New York school district, and 2) 19 teachers who participate in a university-school partnership program in New York and throughout several adjacent states. Seventeen junior high school teachers were from a single building, and 23 high school school teachers were from a single building, both in the same school district. The university-school partnership teachers in addition to teaching regular high school level courses teach college level courses to high school students who receive college credit for each course successfully completed.

The participants were requested to complete a survey questionnaire. One hundred ten surveys were distributed and 61 returned. This yielded a return rate of 56%. The survey assessed the degree to which teachers employ practices characteristic of the instructional design process. This was achieved through combined efforts of interviewing teachers, generating a list of instructional designer practices, and translating the list of instructional design practices into language common to public school teachers.

Procedures

A list of instructional design practices was developed as a result of a content analysis based on an aggregate of recommended design and development competencies extracted from over 60 instructional design models (Andrews & Goodson, 1980; Branch, 1986; Briggs, 1977; Darwazeh, 1986; Dick & Carey, 1990; Gagne, Briggs & Wager, 1992; International Board of Standards for Training, Performance, and Instruction, 1986; Kerr, 1981; Martin, 1984; Reigeluth, 1983; Romiszowski, 1981).

Qualitative data about teacher planning routines was gathered to ascertain the language most commonly used by teachers when preparing to teach. Open-ended interviewing techniques with public school teachers was used to document "what goes through their minds" when they think about the teaching task. The responses of 15 informants was recorded. An informal assessment of the data indicates some natural overlap with the instructional designer practices. These data were used to aid the translation task in creating the survey instrument.

Instrument

A **Teacher Planning Inventory (TPI)** served as the survey instrument. The TPI is a 35- item questionnaire divided into two parts, and was used to find out the ways in which certain important events during teacher planning are carried out by teachers. Part 1 is comprised of the first 24 items and employs a forced-choice Likert scale for teachers to self-report their typical actions or cognitive processes while preparing to teach. Part 2 of the Inventory requests demographic information about the respondent such as age, gender, number of years teaching and typical class size. The list of instructional design practices and the Teacher Planning Inventory are parallel in content, however, the language is purposefully different. The Teacher Planning Inventory avoids instructional design jargon and uses language most familiar to public school teachers.

Many of the things that good teachers do, and which are legitimate instructional design concepts, are done in thought only. Some of the qualifying verbs used in the instructional designer priorities could be revised to reflect the common language of public school teachers. This was addressed throughout the formation of the inventory, and helped make the inventory more effective. Some of the concepts, such as motivational tactics and formative evaluation of instructional episodes, may be greeted by public school teachers with some skepticism. Reluctance to fully subscribe to the use of instructional design models was attributed more to practical constraints which were viewed as "realities" than because teachers believed they are unimportant.

Data Analysis

The overall mean recorded for each respondent on Part 1 of the questionnaire became the score of the participants. Frequency counts were conducted to identify relationships between participant scores by categorical data reported in Part 2. Crosstabulations formed the primary data analysis to determine correlations.

Results

The results indicate that a strong relationship exists between the planning activities of teachers and instructional design practices (Table 1). The overall mean was 7.0 on a 10 point scale, with a mean of 10 indicating the strongest possible relationship. However, there appears to be no correlation between years of teaching experience, class size, grade level, and level of teacher education and teacher practice of instructional design.

The results from Table 1 do suggest that the subject taught does influence the practice of instructional design by teachers. Science teachers reported the lowest mean of 5.3 compared a mean of 7.7 for English and Language teachers. Given the pattern of the mean scores on item 1 through 24 across the subject matter groupings (mathematics, science, etc.) an analysis of variance was conducted (Table 2) to reveal any statistically significant differences across those groups. The results of a liberal test of significance for general linear models indicate that subject taught affects the potential for teachers to practice instructional design.

Because a large percentage of one of the teacher groups (the University Partnership group) were math teachers, a further test for interaction was employed. No interaction effect was detected (F=.64, p=.64) indicating that subject matter taught could have an effect on the dependent variable (Table 3). However, due to the nature of the data collection there is a possible violation of the model, therefore, testing significance against a more conservative critical value is recommended. Use of the appropriate F_{GG} does not indicate statistical significance of difference in means across subject taught groups.

Table 1 Summary of Descriptive Data for Contextual Factors

Background Information	n	Mean	SD
Overall	**61**	**7.0**	**2.5**
Years of Teaching Experience	**56**	**7.1**	**2.4**
1 - 5	3	6.0	1.7
6 - 10	9	6.1	2.9
11 - 15	8	6.6	2.4
16 - 20	19	7.6	1.8
21 or more	17	7.3	2.9
Class Size	**58**	**7.1**	**2.4**
20 or less	25	6.8	2.6
21 - 35	33	7.3	2.3
Grade Level	**25**	**6.8**	**2.8**
Junior High	13	7.0	2.7
Senior High	6	5.8	3.0
Other	6	7.5	3.3
Education Level	**57**	**7.0**	**2.4**
Bachelors	15	6.7	2.3
Masters	39	7.0	2.4
Post-Masters	3	9.3	1.2
Subject Taught	**53**	**7.1**	**2.4**
Math	26	7.6	2.3
Science	7	5.3	1.9
English/ Language	7	7.7	1.9
Social Science	5	7.6	2.5
Other	8	6.1	3.2

Table 2 Summary ANOVA of Subject Taught

	DF	SS	MS	F	p
Between Subjects	4	6966.30	1741.58	3.11	0.02
Within Subjects	49	27428.53	559.77		
Total Within Subjects	53	34394.83			

Table 3 Interaction of Subject by Group

	DF	SS	MS	F	p
Subject	4	6464.63	1616.16	2.69	.04
Group	2	37.45	18.73	.03	.97
Subject into Group (Interaction)	4	1532.54	383.13	.64	.64

Conclusion

The potential for learner achievement is enhanced when teachers practice instructional design. Based on this study, however, additional empirical documentation is required. It appears that some instructional design practices may be beyond the realm of manipulation by public school teachers, and therefore a dialogue between instructional design professionals and public school teachers should be formalized. It is reflected here that instructional designers should consider instructional design models which combine common teacher planning routines with instructional design practices.

References

Andrews, D. H., & Goodson, L. A. (1980). A comparative analysis of models of instructional design. Journal of Instructional Development, 3(4), 2-11.

Anderson, J. R. (1983). The architecture of cognition. Cambridge, Massachusetts: Harvard University Press.

Applefield, J. M., & Earle, R. S. (February, 1990). Instructional Design in the UNCW teacher education program. Paper presented at the Annual Meeting of the Association for Educational Communication and Technology, Anneheim,California.

Association for Educational Communication and Technology. (in press). The definition of educational technology. Washington, D. C.: Author.

Banathy, B. H. (1968). Instructional systems. Palo Alto, California: Fearon.

Banathy, B. H. (1973). A systems view of education, a systems model approach. Seaside, California: Intersystems.

Beilby, A. E. (1974). Instructional development in the public schools: Whose job? Educational Technology, (January), 11-16.

Branch R. C. (1986). Teachers as instructional designers. Unpublished manuscript, Virginia Polytechnic Institute and State University, Self Instructional Curriculum Lab, Blacksburg.

Branch, R. C., Darwazeh, A. N., & El-Hindi, A. E. (1991, February). The influence of instructional designer competencies on teacher planning routines. Paper presented at the Annual Meeting of the Association for Educational Communication and Technology, Orlando, Florida.

Briggs, L. J. (1977). Instructional design: Principles and application. Englewood Cliffs, New Jersey: Educational Technology Publication.

Briggs, L., & Wager, W. W. (1981). Handbook of procedures for the design of instruction. (2nd ed.). Englewood Cliffs New Jersey: Educational Technology Publication.

Chisholm, M. E., & Ely, D. P. (1976). Media personnel in education: A competency approach. Englewood Cliffs, New Jersey: Prentice-Hall, Incorporated.

Darwezeh, A. N. (1986). Curriculum design. Documentary and Research Center at An-Najah National University, Nablus, Palestine.

Dick, W. & Carey, L. (1990). The systematic design of instruction, (3rd ed.). Illinois: Scott, Foresman.

Dick, W., & Reiser, R. A. (1989). Planning effecting instruction. Englewood Cliffs, New Jersey: Prentice Hall.

Earle, R. S. (1985). Teachers as instructional developers. Educational Technology, August, 15-18.

Earle, R. S. (1992, February). The use of instructional design skills in the mental and written planning processes of teachers. Paper presented at the Annual Meeting of the Association for Educational Communication and Technology, Washington, D. C.

Eylon, B., & Reif, F. (1984). Effects of knowledge organization on task performance. Cognition and Instruction, 1(1), 5-44.

Gagne, R. M. (1977). The conditions of learning (3rd ed.). New York: Holt, Rinehart and Winston.

Gagne, R. M., Briggs, L. J., & Wager, W. W. (1992). Principles of instructional design, (4th ed.). New York: Holt, Rinehart, & Winston.

Hannum, W. H. (1988). Designing courseware to fit subject matter structure. In D. H. Jonassen (Ed.), Instructional designs for microcomputer courseware, (pp. 275-296). Hillsdale, New Jersey: Lawrence Earlbaum Associates.

International Board of Standards for Training, Performance, and Instruction. (1986). Instructional design competencies: The standards. Chicago: Altschuler, Melvoin and Glasser.

Kerr, S. T. (1981). How teachers design their materials: Implications for instructional design. Instructional Science, 10, 363-378.

Klein, J. D. (1991). Preservice teacher use of learning and instructional design principles. Educational Technology Research and Development, 39(3), 83-89.

Martin, B. L. (1984). Internalizing instructional design. Educational Technology, (May), 13-18.

Merrill, M. D. (1983). The component display theory. In C. M. Reigeluth (Ed.). Instructional design theories and models: An overview of their current status. New Jersey: Lawrence, Erlbaum Associates.

Merrill, M. D., Reigeluth, C. M., & Faust, G. W. (1979). The instructional quality profile: A curriculum evaluation and design tool. In H. F. O'Nill, Jr. (ed.) Procedures for instructional systems development. New York: Academic Press.

Pratt, D. (1980). Curriculum design and development. New York: Harcourt, Brace, Jovanovich.

Reigeluth, C. M. (1983). Instructional design: What is it and why is it. In C. M. Reigeluth (Ed.). Instructional design theories and models: An overview of their current status. NJ: Lawrence, Earlbaum Associates.

Reigeluth, C. M., Merrill, M. D., & Bunderson, C. V. (1978). The structure of subject matter content and its instructional design implications. Instructional Science, 107-126.

Reigeluth, C. M. & Stein, F. S. (1983). The elaboration theory of instruction. In C. M. Reigeluth (ed.) Instructional design theories and models: An overview of their current status. New Jersey: Lawrence, Earlbaum Associates.

Romiszowski, A. J. (1981). Designing instructional systems. London: Kogan Page.

Sherman, T. M. (1978). Teaching educators to use the systems approach: An instructional analysis. Educational Technology, September, 40-47.

West, L. H. T., Fensham, P. J., & Gerrad, J. E. (1985). Describing the cognitive structures of learners following instruction in chemistry. In L. H. T. West & A. L. Pines (Eds.), Cognitive structure and conceptual change (pp. 29-49). Orlando, Florida: Academic Press.

Wildman, T. M., & Burton, J. D. (1981). Integrating learning theory with instructional design. Journal of Instructional Development, 4(3), 5-14.

Wilson, B. G. (1985). Using content structure in course design. Journal of Educational Technology Systems, 14(2), 137-147.

Yinger, R. (1979). Routines in teacher planning. Theory into Practice, 18 (3), 163-169.

Zahorik, J. A. (1975). Teachers' planning models. Educational Leadership, November, 139-134.

Title:

Developing a Knowledge Base and Taxonomy in Instructional Technology

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Developing a Knowledge Base and Taxonomy in Instructional Technology

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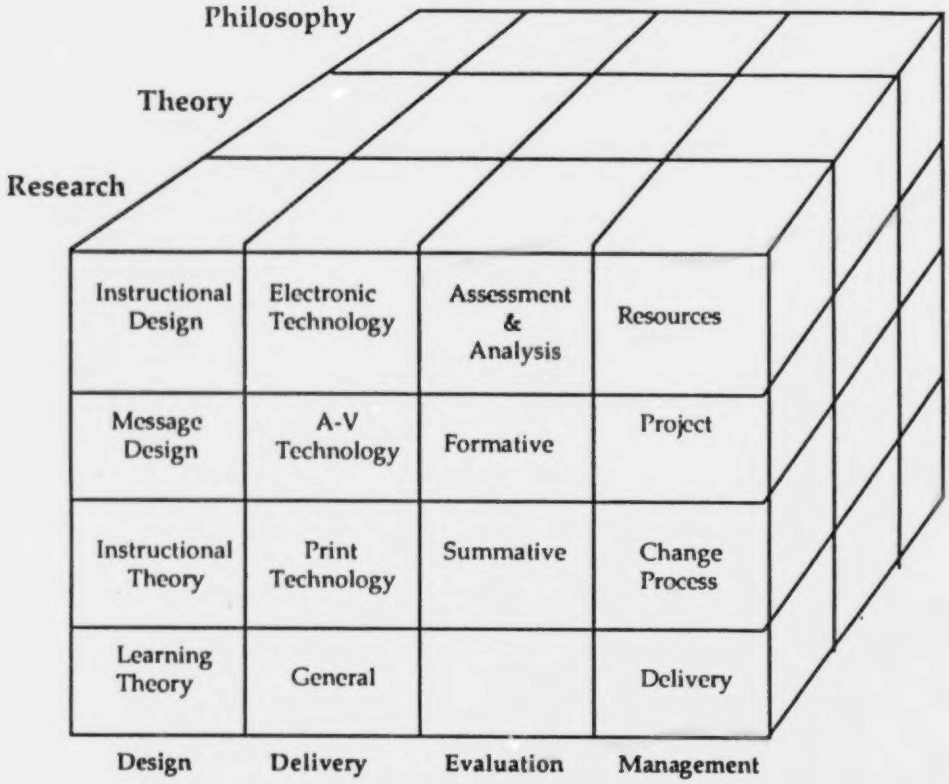
The research reported in this paper is the result of a preliminary investigation and development of a knowledge base for the field of Instructional Design and Technology (ID&T). A knowledge base provides the theoretical and research underpinnings for the field. The development of this knowledge base is important for the education of ID&T specialists and the definition of the field.

Description of the Taxonomy

The knowledge base model is adapted from the ID&T taxonomy model proposed by the Association for Educational Communications and Technology (AECT) Definitions and Terminology Committee. The taxonomy is a three dimensional model as shown in figure 1.



Design	Delivery	Evaluation	Management
Instructional Design	Electronic Technology	Assessment & Analysis	Resources
Message Design	A-V Technology	Formative	Project
Instructional Theory	Print Technology	Summative	Change Process
Learning Theory	General		Delivery

Figure 1: Taxonomy for Instructional Design and Technology as proposed by the Association for Educational Communications and Technology Definitions and Terminology Committee, 1991.

The major side of the model is divided into four areas: 1) design, 2) delivery, 3) evaluation, and 4) management. The second side divides each of these four major areas into subareas such as instructional design and learning theory. The third side is divided into three types of knowledge namely: 1) research, 2) theory, and 3) philosophy.

The purpose of this study was to test the feasibility of using the model to build an ID&T knowledge base. The feasibility was tested by mapping doctoral dissertations into the model.

Background

Practitioners in the field of instructional technology are faced with the task of defining the purpose and role of a dynamic and emerging field of scientific thought. To complete this task they must establish a means for organizing and identifying the relationships emerging from research, theory, and philosophical studies. Given the intricate and complex relationship among factors such as learner characteristics, task, technology, and instructional design, the effort to organize numerous functional categories of interest and information can be overwhelming.

The use of taxonomies and classifications to aid in simplifying these relationships has been widely used with small knowledge bases, especially in computer aided education (Carrier & Sales, 1987; Kozma & Bangert-Drowns, 1987; Knezek, Rachlin, & Scannell, 1988). There have not been any attempts to develop a taxonomy that encompasses the entire field of instructional technology.

This lack of a common framework can lead to the use of "fuzzy" or multiple definitions for the same idea, making generalizations across sub-fields difficult. Thus, the development of a taxonomy, or common knowledge base, is important to the future development of the field of instructional technology. This paper addresses the validity and usefulness of a taxonomic structure proposed by the Association for Educational Communications and Technology (AECT) Definitions and Terminology Committee.

The origin of classification schemes or taxonomies to organize human knowledge bases dates back to the Greeks, and even to primitive man (Sokal, 1974). The purpose of developing classification schemes is to achieve economy of memory, and ultimately to describe the structure and relationship of the items to each other and to similar objects. This classification structure aids in simplifying relationships in such a way that general statements can be made about classes of objects. (Sokal, 1974).

Fleishman & Quaintance (1984) identified several potential benefits for developing a taxonomy of human performance that have direct relevance to the field of instructional technology.

1. To aid in conducting literature reviews. Instructional technologists looking for literature on a particular problem often have difficulty identifying appropriate research descriptors for their search (e.g. instructional technology versus educational technology).

2. Create the ability to generalize to new tasks. In the case of instructional technology, the rapidity of technological change necessitates the ability to transfer what is known from one technology to another. Without this transferability the research base must be recreated for each new technological innovation.

3. Exposing gaps in knowledge by delineating categories and subcategories on knowledge, exposing holes in research or theory.

4. Assisting in theory development by evaluating how successfully theory organizes the observational data generated by research within the field of instructional technology.

Methodology

The model was tested by mapping ID&T dissertations into the three dimensional model. The dissertation titles covered the years 1977 through 1988 and were taken from existing lists of ID&T doctoral dissertations (Caffarella & Sachs, 1988; Caffarella, 1991). These lists contain 1518 dissertations completed at 46 institutions in the United States.

A random sample of 152 dissertations was drawn from these lists. Each of these dissertations was assigned to a specific cell within the model. This classification process was completed independently by two evaluators. When the classifications differed, the evaluators used consensus to determine the appropriate cell.

Results

The results of mapping the dissertations into the model are presented in tables 1 and 2. As shown in the tables, virtually

Table 1
Number and Percentage of Dissertation Titles in Each Cell for the Research Plane

DESIGN	DELIVERY	EVALUATION	MANAGEMENT
Instructional Design 6 titles 4%	Electronic Technology 4 titles 3%	Assessment & Analysis 9 titles 6%	Resource Management 18 titles 12
Message Design 5 titles 3%	AV Technology & Television 13 titles 9%	Formative Evaluation 0 titles 0%	Project Management 4 titles 3%
Instructional Theory 27 titles 18%	Print Technology 6 titles 4%	Summative Evaluation 1 titles 1%	Change Process 15 titles 10%
Learning Theory 30 titles 20%	General Delivery 1 titles 1%		Delivery Management 3 titles 2%
			Personnel Management 3 titles 2%
68 titles 45%	24 titles 17%	10 titles 7%	43 titles 29%

Table 2
Number and Percentage of Dissertation Titles in Selected Cells for the Theory and Philosophy Planes.

Instructional Design -- Theory	1 title 1%
Formative Evaluation -- Theory	1 title 1%
Instructional Design -- Philosophy	1 title 1%

Note: All other cells in the theory and philosophy planes had no title entries.

all of the dissertations were in the research plane with only two dissertations in theory plane and one in philosophy plane. The largest number of dissertations were in the design plane with 45% of the sample. The next largest number was in the management column with 29% followed by delivery with 16% and evaluation with 8%.

The largest number of dissertations in an individual cell was learning theory at 20%. This was followed closely by instructional theory at 18%. The other cells with substantial numbers of dissertations were resource management (12%), change process (10%), and AV technology (including television) (9%).

Every cell on the research plane of the model, except formative evaluation, had at least one dissertation. Only three dissertations were mapped into the theory and philosophy planes. Two new cells were added to the original model in the process of mapping the titles. These cells are "General Delivery" in the delivery plane and "Personnel Management" in the management plane. Four dissertations (3% of the sample) did not fit into any of the cells in the model.

To measure change over time the dissertations were divided into three groups covering the years 1977-1980, 1981-1984, and 1985-1988. The percentage of dissertations in each cell for 1977-1980 were compared against the percentages for 1985-1988. The percentages, as shown in table 3, were relatively equal for the major categories identified above. The only cell with a major increase was electronic technology which rose from no dissertations during the 1977-1980 period to 9% of the total for the 1985-1988 period.

Table 3
Percentage of Dissertations in Major Categories for the Periods 1977-1980 and 1985-1988

Category	1977-1980 Percentage	1985-1988 Percentage
Instructional Theory	19%	18%
Learning Theory	26%	23%
Electronic Technology	0%	9%
AV Technology	5%	7%
Resource Management	7%	11%
Change Process	12%	11%

Conclusions

There are several conclusions from this investigation. First, the model is a reasonable representation of the ID&T knowledge base. Ninety-seven percent of the dissertations fit into an appropriate cell on the model with only four dissertations not fitting the model. Therefore, the model does reflect the doctoral dissertation research that is being conducted in the United States.

The next conclusion is that the ID&T dissertation research has a strong design element. Forty-five percent of the dissertations were in the design plane of the model with 18% in instructional theory and 20% in learning theory. A relatively small percentage (16%) of the dissertations dealt with the delivery of instruction and the hardware components of the field. Thus research in the field is not largely hardware oriented, as many outsiders believe, but has strong research grounding in the design of instruction, particularly instructional and learning theory.

A substantial number (10%) of the dissertations dealt with the change process. This is not a topic traditionally associated with the ID&T field but is a major factor in the successful introduction of new technologies into educational and training settings. This will likely evolve as an important component of the field in the future.

Virtually all of the dissertations were classified as research with only 2% being classified as either theory or philosophy. This finding is not surprising since theory building and philosophical investigations are usually conducted by experienced scholars in the field. Since this study used doctoral dissertations there were not any experienced scholars in the sample.

The last conclusion parallels the development and availability of microcomputers over the past dozen years. Prior to 1980 there were not any dissertations dealing with electronic technology systems. During the period 1985-1988 dissertations of this topic represented 9% of the total.

Limitations

There are several limitations to the investigation in this study. The dissertations were assigned to the various cells based upon the title of the dissertation. Although dissertation titles tend to be very descriptive, many failed to identify the variables under investigation. The meaning of the specific terms in the titles is also subject to interpretation. Therefore, the use of titles only may have lead to the assignment of some dissertations to improper cells.

The boundaries between the cells are not absolute boundaries and some dissertations could be classified in multiple cells. For example, the boundary between instructional theory and learning theory is not an absolute point and some studies could logically be classified in either or both cells.

Suggestions for Further Investigation

The model should be tested with other scholarly literature from the field of ID&T. Specifically the articles from prominent journals should be mapped to test the validity of the model and to better define the knowledge base for the field. If this mapping proves equally valid then the model should be used to build a complete knowledge base for the field of instructional design and technology.

References

Caffarella, E.P. (1991). Doctoral Research in Educational Communications and Technology: A Directory of Dissertations, 1987-1988. Washington, D.C.: Association for Educational Communications and Technology.

Caffarella, E.P. and Sachs, S.G. (1988). Doctoral Research in Educational Communications and Technology: A Directory of Dissertations, 1977-1986. Washington, D.C.: Association for Educational Communications and Technology.

Carrier, C. & Sales, G. (1987). A taxonomy for the design of computer-based instruction. Educational Technology, 27(10), 15-17.

Fleishman, E. A. & Quaintance, M. A. (1985). Taxonomies on human performance: The description of human tasks. Orlando: Academic Press.

Knezek, G.A., Rachlin, S.L., & Scannell, P. (1988). A taxonomy for educational computing. Educational Technology. 28(3), 15-19.

Kozma, R.B. & Bangert-Drowns, R.L. (1987). Design in context: A conceptual framework for the study of computer software in higher education. (Grant No. OERI-86-0010). Ann Arbor: University of Michigan. (ERIC Document Reproduction Service No. ED287436).

Sokal, R.R. (1974). Classification: Purposes, principles, progress, prospects. Science, 185(4157), 1115-1123.

Title:

The Effects of Computer-Assisted Learning-Strategy Training on the Achievement of Learning Objectives

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The effects of computer-assisted learning-strategy training on the achievement of learning objectives

Introduction

Teaching individuals learning strategies is, in effect, teaching someone how to learn. If learning is a knowledge domain in the same way as any subject, for example chemistry or history, then successful learners have organized knowledge about learning processes in the same way that chemists or historians have organized knowledge for their domains (E. Gagne, 1985). There is a real possibility of improving and enhancing learning abilities through special programs of training, education, and other types of intervention (Carroll, 1989). This study examined the effects of computer-assisted learning-strategy training on learning from a computer-based tutorial about microcomputer components.

Previous Research

Snowman (1986) describes learning tactics as specific techniques used to successfully complete a learning task while strategies are general plans decided upon before engaging in a learning activity. He discriminates among kinds of tactics by their objectives which may be memory-directed or comprehension-directed. Memory-directed tactics include the use of mnemonics, outlining, underlining, and summarizing. He refers to questioning as a "comprehension-directed tactic geared more toward understanding the meaning of ideas and their inter-relationships than toward ensuring reliable recall of those ideas" (p. 256).

Generating Questions

Levin (1982) discriminated between the types of generated questions and their effect on types of test questions. Duell (1978) found that college students who generated knowledge and application level questions scored significantly better than students who did not generate questions and that learners generated low-level knowledge questions which were not effective for high-level tests. Andre and Anderson (1979) found that learner-generated questions were more effective than re-reading. They also found that answering teacher-generated questions were equally effective. Singer and Donlan (1982) found that students who were trained benefitted more from student-generated questions than those generated by the teacher.

Training students to generate questions has been an issue in many studies, but researchers observed mixed results from variables such as length and intensity of training, presence or absence of metacognitive components, and varied knowledge levels (Andre & Anderson, 1978-1979; Dreher & Gambrell, 1982; Singer & Donlan, 1982; Frase & Schwartz, 1975).

Simpson (1986) investigated the use of writing as an independent learning strategy and developed PORPE (Predict, Organize, Rehearse, Practice, Evaluate). This strategy was designed to prepare students for success with essay exams. The "Predict" phase of PORPE asked students to generate potential essay questions after reading. Predicted essay questions were directed at higher levels of knowledge. Students were instructed to use verbs such as explain, criticize, compare and contrast. Simpson (1986) found that the strategy required time to master but was effective.
Anthony and Raphael (1987) examined the effects of questioning strategies and found that when subjects generated low-level questions, the strategy was ineffective. Thus, it is apparent that students must be taught how to generate effective questions directed towards the level of learning to be tested.

Purpose of study

Many educational psychologists agree that students need to learn strategies (Kulik, Kulik, & Schwab, 1983). However, the results of training programs vary as much as the training formats and delivery systems (Armbruster, 1987; Cook & Mayer, 1988; Holley & Dansereau, 1984). A systematic evaluation of strategy-training CAI would contribute to the field of study and provide prototypical software. Since microcomputers provide a learning environment that favors individualization, self-pacing, practice, and immediate feedback (Hannafin & Peck, 1988), it is reasonable to consider computer-delivered learning-strategy training. The goal of this study was to determine the effectiveness of specific strategy training on learning about microcomputer components with CAI assessed by specific levels of test objectives.

Information Processing and Memory-directed Strategies

Mayer proposed four components of the encoding process: selection, acquisition, construction, and integration (Mayer, 1988; Mayer & Greeno, 1972; Weinstein & Mayer, 1986). During selection, the learner attends to information received by the sensory register. Acquisition provides for active transfer of information from working memory to long-term memory. During construction, the learner connects ideas and develops an outline organization or schema (Bransford, 1979) or, while reading, forms a macrostructure (Kintsch and van Dijk, 1978). Finally, integration of newly acquired information with information already held in long-term memory is necessary for learning transfer. To be effective, memory-directed learning-strategy training must address these mental processes.

Levels of Learning and Comprehension-directed Strategies

Intellectual skills can be categorized by complexity from skills requiring discrimination, conceptualizations, applying rules, and finally, problem solving (Gagne', Briggs, and Wager, 1988). Teaching learners about these levels of complexity and applying that information to generating questions can, in and of itself, be used as a form of learning-strategy training. By generating questions about information, such as microcomputer components, learners should understand the content well enough to apply rules and solve problems. Delivering that training by microcomputer-based tutorials should facilitate learning because of the characteristics of CAI.

Method

Subjects

Subjects consisted of 60 undergraduate students enrolled in introductory computing courses at Old Dominion University in southeastern Virginia. The mean age of all students was 28 years and ranged from 19 to 43 years. The subjects included only those students whose prior experience with computers consisted of very little word processing, playing games, or using computerized cash registers. As a result of a survey administered to 80 students, those students who reported taking prior computing classes were excluded from the study. In this balanced design, subjects were randomly assigned to one of three treatment groups consisting of comprehension-directed strategy tutorials, memory-directed strategy tutorials, or a control group. As computing students, subjects received 5 participation points towards their final grade.

Instructional and Assessment Materials

A tutorial was developed in order to introduce the learner to microcomputer components. The tutorial was created using Linkway, an authoring system. The learner had the option of selecting topics by clicking the mouse on the approriate space located on a graphic representation of a microcomputer. Learners accessed the tutorial in a Novell LAN microcomputer laboratory. The tutorial covered topics included under the headings: central processing unit, memory, secondary storage, input and output devices, and peripherals. Wherever possible, graphic representations of components supported verbal descriptions and conceptualizations.

Two learning strategy tutorials, developed through the use of Linkway, addressed comprehension-directed strategies or memory-directed strategies. Both tutorials addressed the same content, microcomputer components, and were created within the same format. The same colors, navigational buttons, and fonts were used for each screen and both tutorials possessed the same number of screens or Linkway Pages. Both tutorials concluded with the same practice quiz about microcomputer components. Each tutorial began with the same Linkway Folder, analogous to a Hypercard Stack, that discussed Mayer's information processing model accompanied by examples and opportunities for interaction. Each of Mayer's components, including selective attention, acquisition, construction, and integration, was discussed and examples provided.

The tutorial that addressed memory-directed strategies explained tactics to enhance memory including outlining, organizing information into graphic organizers, and linking new information with prior knowledge. Learners were directed to apply those tactics to the information they learned from the microcomputer-components tutorial by creating outlines, graphic organizers and relating new information to prior knowledge using the notes they took from the microcomputer-components tutorial. The student's name, age, responses to input questions, and generated materials were written to data files on disk. These files were available for inspection by the investigator.

The comprehension-directed tutorial elaborated on the levels of learning and generating questions according to the levels of learning. The tutorial required that students create questions at each level of learning by typing into designated fields within the tutorial. Sample questions were provided and students were permitted to access their notes from the microcomputer-component tutorial. Due to the nature of Linkway, questions that the students generated and entered into the fields were automatically saved when they exited the program so that the investigator could review results. In addition, the student's name, age, and responses to input questions were written to data files on disk.

Evaluation Instruments

Subjects completed two, delayed, and separately administered tests: one requiring cued recall and the other requiring recognition. The cued-recall test listed 50 terms which included microcomputer components, information about memory, and computing acronyms. Students were directed to provide definitions and/or descriptions of each term. The terms were derived from the microcomputer tutorial. The recognition test included 50 multiple-choice items with 10 items at each learning level including discriminations, concrete concepts, defined concepts, rules, and problem solving. The tests were validated with the assistance of computing instructors.

Procedures

This study extended over the period of one week. On the first day of the study, students completed the microcomputer-components tutorial in 75 minutes. The microcomputer-components tutorial directed learners to take notes on the information but did not provide any specific note-taking strategies. Two days later, treatment groups completed the learning strategy tutorials in 75 minutes. On the same day, the control group continued to review the microcomputer-components tutorial without learning-strategy training for 75 minutes. One week later, students completed the recall test in 25 minutes and submitted it to the investigator. Upon completion of the cued-recall test, students completed the recognition test in 45 minutes. In addition, all data files saved to disk were reviewed by the investigator to confirm tutorial completion along with inspection of the fields where the learners typed their questions or outlines.

Results

Cued-recall Test

As seen in Table 1, the group mean scores for the cued-recall test were at or below 50% of the total points. The analysis of variance, however, indicates that the results were significant at the $p < .001$ level with an $F(2, 57) = 11.10$ due to the learning strategy training. Comparing means using the method of Least Significant Difference (LSD) indicated that the treatment group mean scores were signficantly higher than the control group mean scores. However, the comprehension-directed strategy training did not have a significantly different effect on learning as compared to the memory-directed strategy training on the cued-recall test.

Recognition Test

The group mean scores from the recognition test, found in Table 1, ranged from 33.8 to 43.8 out of a total of 50 possible items. According to an item analysis, approximately 60% of the subjects incorrectly responded to questions related to computer memory. The ANOVA indicates that the main effects were significant at the $p < 0.001$ level with $F(2,57) = 13.31$. A comparison of means using the LSD method indicated that the group mean scores from subjects receiving comprehension-directed strategy training was significantly higher than the group mean scores from subjects receiving the memory-directed strategy training at the $p < 0.05$ level. Both treatment groups scored significantly higher than the control group on the recognition test.

Discussion

The results of this study supported the hypothesis that microcomputer-delivered comprehension-directed learning strategy training enhances learning processes assessed at the same levels of learning as the evaluation instrument. Since text-based and lecture-oriented learning strategy training has been shown to be effective (Kulik, et al., 1983), this result is not surprising but adds to an increasing body of research into the effects of microcomputer-based training (Foreman, 1990; Jensen, 1991; Laridon, 1990).

The generally low mean scores from the cued-recall test for both treatment groups and the control group suggest retrieval processes were not enhanced. This may have been due to insufficient interaction with the material for activation of memory that would otherwise result from greater depth of processing (Craik & Lockhart, 1972; Craik & Tulving, 1975). In spite of the low mean scores, however, students who received the learning-strategy training recalled significantly more terms than students who studied the microcomputer-components tutorial even though the control group interacted more with the informational materials than the treatment groups. This supports the findings of other research conclusions that teaching individuals how to learn enhances learning processes (Armbruster, 1987; Cook & Mayer, 1988; Dufflemeyer, 1987). Since students who did not receive learning-strategy training scored significantly lower than the students in the treatment groups, the study methods that they chose were less effective than those learned by the treatment groups (Wade & Trather, 1989).

The results from the recognition test indicate that student-generated questions significantly enhanced the recognition of correct answers using discrimination, conceptualization, rule application, and problem solving on a multiple-choice test. This supports previous research about the use of learner-generated questions

(Andre & Anderson, 1978-1979; Dreher & Gambrell, 1982; Duell, 1978; Levin, 1982; Simpson, 1986; Singer & Donlan, 1982; Frase & Schwartz, 1975). Since the level of knowledge for the test objectives matched the level of questions generated by students, the tactic was effective. This supports the findings of Levin (1982) and Duell (1978) who found that the role of consistency and congruency in testing is critical to the selection and implementation of learning strategies and tactics.

The effects of the memory-directed learning strategy tutorial were more significant than no strategy training and supports Weinstein's conclusions that some strategy use is more effective than non-use (Weinstein, 1982). In addition, item analysis suggests that memory-directed strategies supported learning at the lower levels of discrimination and concrete concepts. This suggests that in cases where memorization of basic vocabulary is critical, memory-directed tactics will enhance learning. Rule-using and problem solving were enhanced by comprehension-directed tactics and strategies. This supports Snowman's (1986) statement that questioning is a "comprehension-directed tactic geared more toward understanding the meaning of ideas and their interrelationships than toward ensuring reliable recall of those ideas" (p. 256). This also explains the lack of effectiveness on retrieval processes.

Implications

The findings of this study support the use of CAI for learning-strategy training. While the learning tactics and strategies were presented separately in this study, further research into the effects of embedded strategies would contribute to an increasing body of knowledge. The consistency and congruency of test items with strategy training and specific content areas would also provide a potential area for research. Additional study about the effects of various CAI characteristics and computer-based learning-strategy training offers a tremendous potential for investigation.

Table 1. Group Mean Scores for the Cued Recall and Recognition Tests.

CUED RECALL

	Mean	Standard Deviation
Comprehension-directed Training	26.3	9.889
Memory-directed Training	25.9	10.612
Control Group	13.8	7.891

RECOGNITION

	Mean	Standard Deviation
Comprehension-directed Training	43.8	3.778
Memory-directed Training	39.4	6.021
Control Group	33.8	7.918

REFERENCES

Andre', M.E.D.A., & Anderson, T.H. (1978-1979). The development and evaluation of a self-questioning study technique. Reading Research Quarterly, 14, 605-626.

Anthony, H. and Raphael, T.E. (1987). Using questioning strategies to promote students' active comprehension of content area material. Occasional Paper No. 9. Eric Document No. ED280011.

Armbruster, B. (1987). Does text structure/summarization instruction facilitate learning from expository text? Reading Research Quarterly, 22, 331-346.

Carroll, J.B. (1989). Intellectual abilities and aptitudes. In A. Lesgold & R. Glaser (Eds), Foundations for a psychology of education, (pp 137-199). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Cook, L. K. & Mayer, R.E. (1988). Teaching readers about the structure of scientific text. Journal of Educational Psychology, 80(4), 48-57.

Craik, F.I.M. & Lockhart, R.S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-684.

Craik, F.I.M. & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology: General, 104, 268 -294.

Dreher, M.J. & Gambrell, L.B. (1982, March). Training children to use a self-questioning strategy for studying expository prose. Paper presented at the annual meeting of the American Educational Research Association, New York.

Duell, O.K. (1978). Overt and covert use of objectives of different cognitive levels. Contemporary Educational Psychology, 3, 239-245.

Duffelmeyer, F. (1987). Maximizing reader-text confrontration with an extended anticipation guide. Journal of Reading; 31, 146 - 150.

Foreman, K. H. (1990). Cognitive characteristics and initial acquisition of computer programming competence. School of Education Review, 2, 55-61.

Frase, L.T. & Schwartz, B.J. (1975). Effect of question production and answering on prose recall. Journal of Educational Psychology, 6, 628-635.

Gagne, E. (1985). The Cognitive Psychology of School Learning. Boston: Litle Brown & Company.

Gagne, R., Briggs, L.J., & Wager, W.W. (1988). Principles of instructional design. New York: Holt, Rinehart and Winston, Inc.

Holley, C.D. & Dansereau, D.F. (1984). Spatial learning strategies: Techniques, applicatons, and related issues. Orlando, FL: Academic Press.

Jensen, E. (1991). HyperCard and AppleShare help at-risk students. Computing Teacher, 18, 26 - 29.

Kulik, C.L., Kulik, J. & Schwab, B.J. (1983). College programs for high-risk and disadvantaged students: A meta-analysis of findings. Review of Educational Research, 53, 397-414.

Laridon, P.E. (1990). The role of the instructor in a computer-based interactive videodisc education environment. Educational and Training Technology International, 27, 365-74.

Levin, J.R. (1982). Pictures as prose-learning devices. In A. Flammer, & W. Kintsch (Eds.), Advances in psychology: Volume 8, Discourse processing. Amsterdam: North-Holland.

Mayer, R.E. (1988). Learning strategies: An overview. In C.E. Weinstein, E.T. Goetz, & P.A. Alexander (Eds.), Learning and Study Strategies: Issues in assessment, instruction, and evaluation. New York: Academic Press, Inc.

Palmer, D.J. & Goetz, E.T. (1988). Selection and use of study strategies: The role of studier's beliefs about self and strategies. In C. E. Weinstein, E. T. Goetz, and P. A. Alexander (Eds.) Learning and study strategies: Issues in assessment, instruction, and evaluation. New York: Academic Press, Inc.

Simpson, M. L. (1986). PORPE: A writing strategy. *Journal of Reading, 29*, 407-414.

Singer H. & Donlan, D. (1982). Active comprehension: Problem solving schema with question generation for comprehension of complex short stories. *Reading Research Quarterly, 17*, 166-186.

Snowman, J. (1986). Learning tactics and strategies. In G. D. Phye & T. Andre (Eds.), *Cognitive classroom learning: Understanding, thinking, and problem solving,* (pp 243-271). New York: Academic Press, Inc.

Wade, S. and Trather, W. (1989). Effect of self-selected study methods on learning. *Journal of Educational Psychology,* 81,40-47.

Weinstein, C.E. (1982). Training students to use elaboration learning strategies. *Contemporary Educational Psychology, 7,* 301-311.

Weinstein, C.E. & Mayer, R.E. (1986). The teaching of learning strategies. In M.C. Wittrock (Ed.) *Handbook of research on teaching.* Hillsdale, NJ: Lawrence Erlbaum.

Title:

Understanding Learning and Performance in Context: A Proposed Model of Self-Assessment

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Introduction

The development of constructs that underlie learning, particularly academic learning has always been a hotbed for inquiry, in as much as we humans are characterized by innate curiosity and the capacity to learn and to understand what we are learning. However, while this has primarily been the domain of philosophers, the emergence of cognitive psychology as a research discipline has provided us with more of the pieces needed to understand learning in context of cognitive processes, internal influences (i.e., individual characteristics) and external influences (i.e., sociocultural influences).

More specifically, the area of metacognition has played a critical role in understanding what develops when an individual learns within academic settings like those generally found in the United States today. One of the manifestations of metacognitive thought is self-assessment. Broadly defined, self-assessment is the act ofevaluating or monitoring one's own level of knowledge, performance, and understanding.

In this paper, we will attempt to discuss self-assessment within a metacognitive framework and take into account the contexts in which self-assessment occurs. Towards this end, we will first give a brief discussion of metacognitive and social psychology theories that pertain to self-assessment. We will then offer an interactive model of self-assessment which delineates some of the possible influences on self-assessment behaviors. Finally, we will discuss the research implications of such a model on approaches to studying self-assessment.

Theoretical Orientations

The Metacognitive Literature

Metacognition may be generally defined as any cognitive activity that concerns itself with any aspect of any cognitive enterprise (Flavell, 1979). Metacognition is believed to be active in such activities as communication, reading comprehension, perception, problem solving, social cognition and varying forms of self-instruction. We believe the work of Brown and DeLoache (1978) and the work of Flavell (1979) are particularly pertinent and instructive in positing a model for self-assessment.

Brown and DeLoache (1978). They assert that one of the most fundamental differences between the experienced learner and the naive learner is the increasing capacity for metacognition, which they call self-regulation and control of knowledge. They believe that along with an increase in learning, there is a concurrent increase in metacognitive activity, which allows the individual to monitor problem solving techniques and then modify them.

Brown and DeLoache further state that individuals follow a relatively similar pattern of learning. First the absolute novice shows little self-regulation (metacognitive activity). Then, as he becomes more familiar with the necessary rules and subprocesses required to learn the subject, he increasingly enters a more active period of deliberate self-regulation. Finally, there is a period when the use of rules and subprocesses to access knowledge become mostly automatic. The individual has become an expert. Though their studies have primarily been on children, we believe that at any age, this developmental pattern is operative. What develops seems to be a schema or internalized working model of the individual's self-regulation or, in our terms, the individual's self-assessment process.

Although we may intuitively believe that adults have a sophisticated and fully developed schema of self-regulation or self-assessment, it may not necessarily be the case. What may distinguish the acquisition of this schema may be the constraints of internal influences (individual characteristics) and external influences (sociocultural influences).

Flavell (1979). One of the more renowned theorists in the metacognitive area, Flavell views metacognition in terms of metacognitive knowledge and metacognitive experience.

Metacognitive knowledge denotes the area of acquired knowledge that deals with what an individual knows about how he thinks and how others think. That is, it is the knowledge and beliefs that one has accumulated through experience which concern the human mind and its cognitive processes. Some of this stored knowledge is declarative (e.g., knowing that you have poor memory). Other metacognitive knowledge may be procedural (e.g.,you know how to improve your poor memory by the use of supplementary aids like notes or lists).There is also metacognitive knowledge that is both procedural and declarative (e.g., your ability to know that writing lists helps your poor memory).

Flavell views metacognitive knowledge as roughly subdivided into knowledge about persons, tasks, and strategies.

Persons includes knowledge and beliefs one might acquire concerning what individuals are like as thinkers.

It can be further broken down into knowledge and beliefs about cognitive differences within people (e.g., you know that you are better at one subject than another), between people (e.g.,knowledge about other people's social cognitive skills), and cognitive similarities among all people (in other words, the universal properties of human cognition.

Tasks includes two subcategories. First is the nature of the information to be addressed when facing a cognitive task (e.g., the difficulty of taking a comprehensive exam). Second is the nature of the task demands (e.g., You know it is easier to remember the general theme of a story than its exact wording).

Strategies includes your knowledge of the ways that you can succeed in achieving your cognitive goals (e.g., remembering a poem, comprehending a theory, or solving a problem). The principal role of metacognitive strategies is to help you successfully carry out cognitive activities (e.g., knowing that you must monitor your time during an exam).

Finally, Flavell believes that metacognitive knowledge is not qualitatively different from other kinds of knowledge. Like other knowledge it is probably accumulated in a slow and gradual fashion through experiences in various cognitive activities. It is probably often automatically activated through stimulus response processes that detect and appropriately respond to familiar cognitive situations. Also, metacognitive knowledge can oftentimes be insufficient, inaccurate, not reliably retrieved and not used when appropriate.

Metacognitive experience is a concept which refers to cognitive or affective experiences that occur during some activity that gives insight to that activity. Metacognitive experiences can be brief and simple (e.g., a brief puzzlement about a friend's behavior) or lengthy and comeple (an obssessive desire to understand a friend's behavior). They may also occur at any time before, during, or after a thinking activity (e.g., thinking about how you are doing on different parts of an exam). Many metacognitive experiences tend to include your perpception of previous progress you have made, progress you are currently making, or progress you will make in a given activity. Such metacognitive experiences occur in situations that would be expected to engender careful, conscious monitoring and regulation of one's own cognition. Metacognitive experiences serve useful functions in ongoing cognitive activities. For instance, if you have trouble solving a problem, a metacognitive experience may help you to restructure your thinking so that you can reach a solution. In this sense, a metacognitive experience is adaptive. Moreover, metacognitive experiences tend to be influenced and shaped by whatever relevant metacognitive knowledge you have acquired. In turn, metacognitive experiences must also contribute information about persons, tasks, and strategies to one's developing store of metacognitive knowledge.

According to Flavell, it would seem that metacognitive knowledge, metacognitive experience, and cognitive behavior are constantly informing and eliciting one another during the course of a task.

Social Psychology Literature

Learning does not occur in a vacuum and is influenced by a number of different components which can be loosely grouped into external influences (sociocultural influences) and internal influences (individual characteristics). The work of social cognitivists and the emerging field of cultural psychology is particular salient to our proposed model for self-assessment.

Social cognitivists like Vygotsky (1962) and Cole and Scribner (1975) bring to cognitive psychology the premise that cognitive activities develop and are modified within sociohistorical and cultural contexts. The effect of these influences can be observed in an individual's choice of activities, motives, and priorities. Thus, the individual's schema for self-assessment is based not only on metacognitive knowledge and experience but also on a variety of internal and external influences. The emerging discipline of cultural psychology also speaks to this issue in that it views individual development and functioning as occurring in particular intentional worlds--that is within unique sociocultural environments that have within them unique communities of individuals with unique beliefs, desires, emotions and purposes (Shweder, 1990). From this perspective, we would expect metacognition to be influenced by an individual's level of involvement and commitment along different social domains (i.e.,school, family, workplace, etc.). In this way, learners (at any age) can be seen as belonging to interconnected systems which influence their learning at every turn.

Possible Model for Self-Assessment

What higher order thinking occurs during an individual's self-assessment? What influences this self-assessment capacity? How can we improve an individual's ability to self-assess, and does this ability hold along different knowledge domains? We believe these questions can best be answered by positing a self-assessment model that takes into account the metacognitive and social psychology theories we discussed above.

In this model, self-assessment behaviors are really manifestations of metacognitive processes involving metacognitive knowledge and metacognitive experience. These metacognitive processes make up an individual's schema for self-assessment. This schema is part of the individual's overall cognitive processes. However, at the same time, the self-assesement schema acts as a mediator of cognitive activities in different knowledge domains. Thus, we may view the self-assessment schema as a generalized cognitive process that is operable along a wide array of knowledge domains.

The operation of this self-assessment schema may occur at two levels. During a task, a person may perform frequent incremental assessments of his performance in order to reach completion. The self-assessment schema is utilized in a formative fashion in order to monitor and modify the on-going task. Once the individual has completed the task, he again utilizes the self-assessment schema to do a summative evaluation of his performance on the overall task. He may then use this summative evaluation to modify his self-assessment schema, which will be used again at some future task.

However, all cognitive processes (e.g., metacognition and particularly self-assessment) do not merely occur independent of other influences, as we mentioned earlier in our social psychology section.

External influences in an academic environment may include the school. Within a school setting, the goals, curriculum, training, faculty-student interaction , etc. may affect the individual's ability to self-assess. The individual's family life, culture, neighborhood, and the media may also impact on self-assessment.

Any task which requires the use of the self-assessment schema is itself embedded within these external influences. The tasks may come from the school (e.g., performance on exams), from the family (e.g., interaction dynamics among family members), or from the neighborhood, etc. The completion of these tasks provide the individual with opportunities to activate his self-assessment schema. Subsequently, he modifies his schema to account for his task performance and the external factors which influenced this performance.

In addition, internal influences (such as various individual characteristics) can affect the components of the self-assessment schema. A person's temperament, such as whether one is an introvert or an extrovert, may affect how the self-assessment schema is utilized in a given task. In addition, an individual's self-esteem or self-concept, motivation, school achievement, social skills, etc. also play a role in influencing the components and formation of this self-assessment schema, thus ultimately influencing the individual's performance in a task.

Because these internal and external influences act as mediators of the self-assessment schema, they provide opportunities or avenues to intervene by modifying the schema, which , in turn, may change an individual's performance on a task. Moreover, the interactions among the self-assessment schema, the internal influences and the external influences are not just one-way interactions. The self-assessment schema are not only being influenced by external and internal influences. The self-assessment schema (and all other cognitive processes) also impact on these external and internal factors. For instance, modifying an individual's previously ineffective self-assessment schema to a more effective schema may improve his self-concept and his self-confidence (internal characteristics), as well as also improve his performance at school (external environment).

Conclusions and Implications for Research

This paper provided a brief discussion of the metacognitive literature and the social psychology literature as it may pertain to self-assessment as a social cognitive construct. These theoretical frameworks posited (mainly Flavell's metacognitive components and the social cognitivists (Vygotsky, Cole and Scribner) provided the basis for a proposed model of self-assessment in an academic environment. Much of the self-assessment literature out there seems to be limited to describing the manifestations of self-assessment behaviors in various student populations. The utility of providing a model of self-assessment is that it provides a contextual framework in which we could discuss various self-assessment behaviors in a less limited manner. How can we observe developmental change in self-assessment?

Brown and DeLoache (1978), using recommendations made by Cole and Scribner (1975), advocated three components of researching developmental change in competencies. It calls for a synthesis of ethnographic and experimental methods and for the investigation of particular activities along a range of situations (from natural observations to experimental). First, they believe one should examine the individual's understanding of the experiment or task and his role in this. One should be fully aware of the task demands and how they appear to the individual being tested. Second, they believe in "experimenting with the experiment". That is, researchers should use variations of a paradigm applicable to the individuals being studied. Third, researchers should investigate the same process in a range of situations, whether in naturally-occurrring or experimental situations.

I believe the current self-assessment literature can benefit from conducting research in this manner. The complexity of self-assessment and its importance to learning behooves us to make certain that research in this area goes beyond merely descriptive analysis of self-assessment behaviors. The development of a viable model for self-asessment can be instrumental in enhancing our understanding of what exactly develops when one goes from a novice learner to an experienced learner in a knowledge domain.

References

Brown, A.L. & J.S. DeLoache. (1978). Skills, plans, and self-regulation. In R. Siegler (Ed.), Children's Thinking: What Develops?. Hillsdale, NJ: Lawrence Erlbaum.

Cole, M. & S. Scribner. (1975). Theorizing about socialization of cognition. Ethos, 3, 249-268.

Flavell, J. (1979). Metacognition and cognitive monitoring: A new are of cognitive-developmental inquiry. American Psychologist, 34(10), 906-911.

Shweder, R. (1990). Cultural Psychology, What is it?. In J.W. Stigler, R.A. Shweder and G. Herdt (Eds.), Cultural Psychology: Essays on comparative human development. Cambridge, U.K.: Cambridge University Press.

Vygotsky, L.S. (1962). Thought and Language. Cambridge, MA: MIT Press.

Title:

The Perception of the Educational Value of Channel One Among Secondary Level Teachers and Students

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The Perception of the Educational Value of Channel One Among Secondary Level Teachers and Students.

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Whittle Communication's Channel One is an educational broadcast service designed specifically for teenagers. This twelve minute daily broadcast claims to deliver top-quality news and information to schools, via satellite, with state-of-the-art production techniques. By creating a program that is completely original, Channel One hopes to consistently deliver riveting, age-appropriate coverage to an audience lacking in consistent news viewership. The purpose of this study was to describe student and teacher attentiveness to Channel One, and the perceived educational value and the quality of the presentation of Channel One within the Lakota School District of northwestern Ohio. A self-report questionnaire was used to survey all students (n=512) and teachers (n=33) at the junior and senior high schools. The results show that the mean viewing time of Channel One by students is 8.5 minutes, and that 74.8 % of the students supported Channel One's claim that the service provides new ideas to think about. However, 78.9% of the students do not seek out more information about a topic shown on Channel One. In terms of the presentation of Channel One, 72.6% of the students rated the overall quality of the programming to be good or excellent. The average viewing time for teachers was 10 minutes, with 87.9% indicating that Channel One provides new ideas to think about. Ninety-seven percent of the teachers stated that the overall quality of Channel One was good or excellent. Overall, the analysis of the data seems to support the effectiveness of Channel One in increasing students' awareness of news and current events.

Introduction

Studies and commentaries ("A Nation Still at Risk," 1989: Harris, 1989), suggested that American education is in serious trouble and that graduates of American high schools are not competitive with their counterparts in many foreign countries. Educators, politicians, and social critics have offered reasons for the problems with education, but most all agreed that American students are deficient in areas such as science, mathematics, geography, history, and cultural literacy. Particularly troublesome to many was the fact that a number of students had little, if any, awareness of basic current events and issues. The education plight is reflected in some of the following educational indicators:

*Six percent of seventeen-year-old high school students can solve multi-step math problems and use basic algebra.
*Seven percent are able to infer relationships and draw conclusions from detailed scientific knowledge.
*Given a blank map of Europe and asked to identify particular countries, young American adults typically give the correct answer less than one time in four (Finn, 1989).
*Twenty-seven million adults in the United States are functionally illiterate.
*Forty-six million adults are considered "marginal" literates.
*The drop-out rate ranges between 40 and 60 percent in areas like Los Angeles, Boston, Chicago, Detroit, and New York.
*Each day, nearly 3800 teenagers, nationwide drop out of school, according to the Department of Education (Townley, 1989).

From the educational indicators presented, it is clear that the panel which produced the "Nation at Risk" report in 1983 had good reason to be alarmed. The panel indicated that the United States had to act promptly or an educational meltdown would occur, the educational system would crack, our culture erode, our economy totter, our national defenses weaken (Finn, 1989).

In 1989. a grim portrait of the public school system emerged from the Second Gallup *Phi Delta Kappa* Poll, which surveyed the attitudes of U.S. teachers toward the public schools. Teachers tend to regard themselves as martyrs. They believe that they are unappreciated and underrewarded, and they blame everyone but themselves for recognized school problems (Elam, 1989). The most frequently mentioned reason for the public school system's dyer situation, as cited by 34% of all teachers (830 respondents-57.2% elementary teachers, 32.7% secondary teachers, 4.2% both, 5% other) in the 1989 Gallup Poll, is parents' lack of interest and support. Others charged that parents do not help students realize the importance of preparing for the future. Some pointed to parental apathy, while others said that parents lack faith in the school system. Lack of proper financial support was the second most frequently mentioned reason; teachers acknowledge that the lack of financial support is related to other school problems. Other reasons mentioned as factors leading to the public education system's possible meltdown were: pupils' lack of interest/truancy (26%), poor curriculum/poor standards (6%), communication problems (3%), large schools/overcrowding (4%), teachers' lack of interest (3%), difficulty in getting good teachers (2%), and low teacher salaries (7%).

A semi-literate population, lacking both good learning habits and basic skills and knowledge, cannot support a productive economy. Scholars and studies often speak of potential solutions which can be used as guides to improve the educational system. Chester Finn (1987) offered direction for the improvement of the educational system. Some of his recommendations indicate that we must:

> *Focus public regulation of education on ends, not means--professional educators need the latitude to organize schools and determine what happens within them.
> *Let the schools manage themselves--each school should make its own key educational management decisions.
> *Promote more imaginative school leadership.
> *Engage parents as well as schools.
> *Make better use of technology--technology allows the teacher to transform the classroom into a place where teachers teach, children learn.

Finn's final recommendation--make better use of technology--did not fall on deaf ears. The classroom has been profoundly affected by technological innovation, from computers to televisions. The use of these new innovations create new environments and new forms of knowledge. The classroom is vulnerable to technological innovation (Kaha, 1990), and as Finn (1987) has indicated the teacher should make better use of the technology. As Kaha (1990) states: "The classroom cannot exclude the impact of television." As Marshall Mcluhan pointed out, one can be absorbed by the glowing screen of television in a way that is not possible with books.

Between 1958 and 1960, Schramm et al., conducted the landmark study of the effects of television on North American children, as reported in Television in the Lives of Our Children (1961). The primary focus of this study was on the uses and functions of television for various categories of children. The study found that public affairs and news programs were not viewed consistenetly until the teenage years. Viewing of these types of programs depended on the teenager's age, sex, and mental development. Their results concluded that the "brighter" teens were the first to turn away from traditional entertainment programs in favor of news and public affairs content. These results did not mention the use of television in the classroom, but it did recommend tailoring television programming to the desired audience to achieve maximum cognition and development.

In the 1970's, teachers were still learning how to use the instructional television to teach teens, and in turn they were still learning how to integrate video into their curricula (Landay, 1989). During this period Walter Cronkite was inspired by the vision of a unique offering to the nation's young, specifically through his PBS series. Cronkite dreamed of linking the power of television to the American public education system. He wanted to install satellite antennas on the roof tops of the nation's high schools to deliver to as many students as possible the nation's best teachers (Landay, 1989). From Cronkite's idea, Satellite Educational Services, Inc. was created in the 1970s and began producing *Why In The World* in the 1980s. Cronkite was not the only person who had great visions of television's power: The use of television in the classroom had emerged, and the battle between the big communication companies had begun. Ted Turner, the cable-ready King with CNN Newsroom, and Christopher Whittle, an innovative leader of the print industry with CHANNEL ONE, are competing for supremacy.

While Turner, arguably, needs no introduction, Whittle may. CHANNEL ONE is distributed by Whittle Communications L.P. of Knoxville, Tennessee. Christopher Whittle heads a media empire which is valued at more than $400 million. In March of 1990, Whittle began offering a daily twelve-minute program of current events and news. CHANNEL ONE has five educational goals:

*To enhance cultural literacy.
*To promote critical thinking.
*To provide a common language and shared experience.
*To provide relevance and motivation.
*To strengthen character and build a sense of responsibility.

CHANNEL ONE claims to offers "a unique combination of elements," such as:

> * Instructional value-CHANNEL ONE's format incorporates a variety of factual information that is related with a teenage slant to current events.
> *Video medium-featuring the use of graphics and imaging techniques familiar to today's teens.
> *The immediacy aspect that is generated by a broadcast news format. The news is presented in a language geared to teens.[1]

These elements, along with others, are offered to junior high and high schools. The schools receive $50,000 worth of hardware (a satellite dish, a VCR-based recording and playback station, and televisions) in exchange for the guarantee that the newscast will be aired on a daily basis and viewed by the school. Of the twelve minutes beamed to students in classrooms, two minutes are commercials. As of March 1991, which marked CHANNEL ONEs' first anniversary, 8270 (Sylvester, 1991) schools were signed up for the standard three-year contract. After the three year period, the school can renew its contract or decide to terminate their relationship with Channel One, at which time the equipment will be returned.

Whittle Communications realizes that children generally do not watch news. They are using technology in an effort to link news to the educational system, and thereby improve the educational system. Therefore, the purpose of this study was to describe teachers' and students' attentiveness to Channel One, the perceived educational value, and the quality of presentation of CHANNEL ONE.

Methods

The school district from which the subjects were obtained is the largest school district, in land area, in the state of Ohio. Channel One has been broadcasting in the senior high school since September, 1990, and in the junior high school since January, 1991.

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[1] Note: Channel One Information obtained from the Channel One Media Kit, prepared by Whittle Communication, Inc.. Knoxville, Tennesse.

The district is located in three rural Northwestern Ohio counties, where the land is used primarily for farming. This area is characterized by many small towns and villages that support mainly blue collar industries and agriculture. The per capita income, in 1988, was $22, 638 (state average was $29,195). The 1990 Vital Statistics on Ohio School Districts indicated that 96.9% of the residents of this school district were Caucasian.

The school district contains one senior high school (grades 9-12) and one junior high school (grades 7 & 8), from which the 512 subjects were drawn. The 1990 average attendance rate of the students in the district was 93.3% (state average was 93.4%), with an average graduation rate of 74.6% (state average was 77.8%). Approximately 49% of the students who graduated in 1990 enrolled in some form of higher education. The results from this study showed that 89% of the students surveyed are planning to attend some form of higher education after they graduate. Table 1 indicates the number of students who responded to the questionnaire by gender, within each grade.

Insert Table 1 about here

There were 512 responses from 600 questionnaires distributed (85.3%) to students in grades 8 through 12. Nearly equivalent numbers of responses were received from both males (254) and females (258). There were 33 responses from 33 questionnaires distributed to teachers in both schools, with 15 responses from male teachers. All subjects were given the option of not participating in the study.

Two self-administered questionnaires developed by the researchers, one for students and one for teachers, were used to collect the data. This method (questionnaire) was selected because of the relatively large sample of students and teachers, and the data collection process' relative lack of interference with normal school activities. The questionnaires were administered by the homeroom teacher during the homeroom period, before the students were to watch Channel One. After ten minutes, the questionnaires were collected by the teachers and returned to the school office for retrieval by the researchers.

Each of the two questionnaires was one page in length, and was divided into four sections: degree of attentiveness to Channel One, educational value of Channel One, quality of the presentation of Channel One, and demographic data. For the first two sections, the subjects were asked to record their average daily viewing time of Channel One and respond to several yes/no questions about their level of attentiveness to various parts of the program and its educational value to them. These questions were derived from Channel One's statements of their intended educational goals for the program.[1] In the third section, the quality of the presentation of Channel One, the subjects were asked to assign letter grades (A through F) to various characteristics of Channel One (graphics, music, the hosts, commercials, etc.). These characteristics are standard media aesthetic qualities derived from Herbert Zettl's research in the areas of media asethetics and television production. They were selected to obtain the subjects' perception of various aesthetic qualities of Channel One, as well as their perceptions of the information content and its delivery (see Zettl, 1990, for a complete description of these characteristics).

Findings

The average viewing time of Channel One by the students in this study was 8.5 minutes, of the 12 minutes available (71.8%). The average viewing time of Channel One by teachers was 10 minutes (83.3%). These findings indicate a relatively high degree of viewing by both groups of subjects. The high degree of attentiveness may be attributed to the recent implementation of Channel One in the senior high school (September 1990) and the junior high school (January 1991). Thus, it is possible that the newness of the service may be creating the high interest level. Given that at the present time, there is no other available evidence with which to compare these result a longitudinal study of Channel One viewing attentiveness would provide a necessary benchmark for future comparisons.

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[1] Note: Channel One Information obtained from the Channel One Media Kit, prepared by Whittle Communication, Inc., Knoxville, Tennessee.

The responses related to the attentiveness to the various components of the broadcast as well as the perceived educational value of Channel One are shown in Table 2. The responses were obtained via yes or no answers and are reported interms of the percent of "yes" responses.

Insert Table 2 About Here

The responses obtained in Table 2 should be considered together because the subjects' degree of attentiveness contributes to the perceived educational value of Channel One. A high degree of attentiveness (over 65%) was reported, with the exception of the viewing of the commercials (51.2%). This may be attributed to the repetition and lack of originality in the commercials. Further study of the commercials within Channel One may provide more concrete information. Under the variable of perceived educational value, the information on Channel One is not generally used in classroom discussion by the students (38.1%), nor in their out-of-school activities (33.7%). The students very rarely seek out additional information about topics discussed on Channel One (20.4%), and they rarely ask questions about this information (30.8%). On the other hand, Channel One does provide new ideas to think about (72.7%), and it does make students more aware of other cultures (77.3%). Sixty percent indicated that Channel One does provide positive role models. Therefore, for this group of students, the data supports Channel One's original programming goals of enhancing cultural literacy and promoting critical thinking. Students in all grade levels are receiving new information from Channel One, especially dealing with other cultures. This cultural information is most often shown during the Feature segment, which is also the highest viewed segment of the program. However, it does not support the goal of providing relevance and motivation, as students do not pursue additional information outside of the Channel One environment. This could reflect a continuation of their personal viewing habits of television at home.

With respect to the quality of the presentation of Channel One, the responses are tabulated in Table 3. This table summarizes both the junior and senior high school students' evaluation of the program's visual, aural, and message content.

Insert Table 3 About Here

Table 3 summarizes the students' perceptions of the quality of the presentation of Channel One. Approximately 72% of the students rated the overall quality of Channel One's presentation to be good or excellent. Channel One was also given high marks in its ability to communicate information to the viewer (77% good or excellent). In the areas of visual style (graphics, maps and charts, colors, on-screen lettering), Channel One received high marks again (no less than 75% good or excellent). The use of student and celebrity reporters also fared well with the students (67% good or excellent). However, the pacing, music and visual excitement of the program was not well received by the students (no more than 56% good or excellent). Therefore, Channel One appears to provide common knowledge and shared experiences through familiar production techniques and personalities. Many students commented that the style of Channel One is similar to that of programs on MTV and Nickelodeon, which use large on-screen lettering, visually exciting graphics, and identifiable and likable personalities. Some of the lack of visual excitement may be attributed to the news content of the program.

In Table 4, the teachers' degree of attentiveness and perceived educational value of Channel One are tabulated. Table 5 summarizes the teachers' evaluation of the program's visual, aural, and message content.

Insert Table 4 About Here

Insert Table 5 About Here

The responses in Tables 4 and 5 summarize the teachers' degree of attentiveness and the preceived educational value and quality of the presentation of Channel One. All of the Channel One program segments were highly viewed by the teachers (no less than 87% attentiveness), except for the commercials (42%). This may indicate that the teachers find the commercials to be of little value to them. This is not really surprising, since the commercials are targeted toward the younger student audience. As for perceived educational value, the teachers also highly rated Channel One's performance in cultural awareness (100%), providing positive role models for students (97%), and providing students new ideas to think about (88%). The teachers, like the students, reported that Channel One was not generally being used in classroom discussion (58%) or to motivate them to seek out additional information on Channel One topics (42%).

Overall, 97% of the teachers gave Channel One's presentation a grade of good or excellent. The highest rated elements were again the visual style elements of graphics, lettering, etc. (no less than 94% good or excellent). Again, the commercials were not very well rated, with only 54% giving them a grade of good or excellent.

Summary

Channel One appears to be accomplishing most of its intended programming goals with its unique format. Students and teachers responded positively to Channel One's ability to provide new ideas in the learning environment, to enhance cultural literacy, and to provide positive role models. Channel One also has been able to effectively reach the teenager with programming that they like and are familiar with. It has been able to get students interested and involved in ideas and issues in which they may have not been previously exposed. However, Channel One falls short in its ability to promote motivation outside the Channel One environment . This may be caused by the lack of follow-up on issues and concepts by teachers in the classroom. Instructional material is provided with the program, but it appears that it is not being utilized in the classroom. As Channel One becomes an established part of the school day in the future, it may become more useful to teachers and students.

Future research on Channel One may be able to address these concerns. The timing of this study, shortly after the implementation of Channel One in these schools, may have obtained more positive results than expected because of Channel One's newness in the learning environment. Future studies, especially longitudinal in design, would enable researchers to examine this concern. Future studies might also examine a number of different school settings where Channel One is present to possibly construct valid generalizations about the use of Channel One as an educational tool. Another area for future research is the effectiveness of the commercials within the program. Although this study found that the commercials were not generally viewed, their impact on this young audience could be analyzed in greater detail.

References

Elam, S. (1989, June). The Second Gallup Phi Delta Kappa Poll of Teachers' Attitudes Toward Public Schools. Phi Delta Kappan, 70 (10), 785-801.

Finn, C. (1989, May). A Nation Still at Risk. Commentary, 87 (5), 17-22.

__________. (1987, September/October). Education that works: make the schools compete. Harvard Business Review, 65 (5), 63-68.

Harris, I. (1990, April). Education: Does It Make Any Difference When You Start? Vital Speeches, 56(12), 371-375.

Kaha, C.W. (1990,Fall). Learning Environments For the Twenty-First Century. Educational Horizons, 45-49.

Landay, J.M. (1989,March) Battle for the Vidkids. Human Communication, 68, 61-68.

Mcluhan, Marshall. (1964). The Extensions of Man. New York: McGraw-Hill.

Schramm, W., Jack Lyle & E. Parker. (1961). Television in the Lives of Our Children. Stanford, CA: Stanford University Press.

Sylvester, K & M. Angle., (April 19, 1991). Channel One still creating controversy. Sentinel-Tribune, p. 3.

Townley, P. (April 1, 1989). Business and Education Reform. Vital Speeches of the Day, 55 (12), 354-356.

Zettl, H. (1990). Sight, Sound, Motion: Applied Media Aesthetics. 2nd Ed. Belmont, CA: Wadsworth Publishing, .

TABLE 1
DESCRIPTION OF SUBJECTS

CHARACTERISTICS	SUBJECTS						
	STUDENTS (n=512)						TEACHERS
	7TH	8TH	9TH	10TH	11TH	12TH	(n=33)
TOTAL	102	77	102	82	74	75	33
MALES	53	33	49	43	35	41	16
FEMALES	49	44	53	39	39	34	17

TABLE 2
THE STUDENTS' DEGREE OF ATTENTIVENESS AND THE PERCEIVED EDUCATIONAL VALUE OF CHANNEL ONE
(PERCENTAGE OF YES RESPONSES, n=512)

TOPIC	QUESTION	JR. HIGH n=179	SR. HIGH n=333	TOTAL n=512
ATTENTIVENESS	Do you typically watch the Lead story?	77.6	78.9	78.4
	Do you typically watch the Focus segment?	62.3	66.5	65.0
	Do you typically watch the Feature segment?	79.8	78.6	79.0
	Do you typically watch the Pop Quiz?	80.9	72.1	75.2
	Do you typically watch the End piece?	61.2	67.6	65.4
	Do you typically watch the commercials?	61.7	45.4	51.2
PERCEIVED EDUCATIONAL VALUE	Is the information on Channel One **generally** used in classroom discussion?	42.1	35.9	38.1
	Is the information on Channel One **generally** useful in your out of school activities?	41.5	29.3	33.7
	Does Channel One provide **new** ideas to think about?	75.4	71.2	72.7
	Do you **ever** ask questions about the information shown?	41.5	24.9	30.8
	Do you **ever** seek out more information about a topic shown?	28.4	16.0	20.4
	At time, does Channel One relate to what you are currently studying in class?	68.3	76.8	73.9
	Does the information on Channel One make you **more aware** of other cultures?	78.1	76.8	77.3
	Does Channel One provide you with **positive** role models?	63.9	58.4	60.4

TABLE 3
THE QUALITY OF THE PRESENTATION OF CHANNEL ONE
(PERCENTAGE OF GRADE GIVEN TO EACH ITEM)
TOTAL n = 512, SR. HIGH = 333, JR. HIGH = 179

ITEM	LEVEL	PERCENTAGE OF GRADE				
		A	B	C	D	F
The ability of Channel One to effectively communicate the information to the viewer	**Jr. High**	23.4	47.4	25.1	2.3	1.7
	Sr. High	33.4	47.6	15.4	2.7	0.9
	Total	29.8	47.5	18.7	2.5	1.2
The style of graphics used	**Jr. High**	43.0	34.6	18.9	1.7	1.7
	Sr. High	38.4	40.2	18.1	1.2	2.1
	Total	39.6	38.1	18.7	1.3	2.1
Colors used during Channel One	**Jr. High**	52.5	27.1	15.8	2.2	2.2
	Sr. High	42.5	36.8	16.1	2.4	2.1
	Total	45.6	33.1	15.8	2.3	2.1
Maps and charts used	**Jr. High**	44.9	34.1	15.3	3.9	1.7
	Sr. High	51.1	30.5	13.3	4.2	0.9
	Total	48.1	31.7	14.0	4.0	1.2
On-screen lettering used	**Jr. High**	42.8	30.8	16.6	4.0	5.7
	Sr. High	52.7	25.8	13.2	4.3	3.9
	Total	48.1	27.1	14.2	4.0	4.4
Type of music used	**Jr. High**	22.9	26.8	33.5	7.8	8.9
	Sr. High	19.6	29.1	27.5	10.4	13.4
	Total	20.4	27.9	29.4	9.4	11.7
Loudness of music used	**Jr. High**	27.4	33.7	28.6	6.3	4.0
	Sr. High	20.6	35.5	30.6	5.8	7.6
	Total	22.5	34.2	29.4	6.2	6.3
The pacing of Channel One	**Jr. High**	20.8	31.4	35.9	6.2	5.6
	Sr. High	18.2	32.2	38.6	6.9	3.9
	Total	18.8	31.5	37.5	6.7	4.4
Visual excitement	**Jr. High**	23.2	37.3	25.4	6.2	7.9
	Sr. High	19.3	30.7	31.3	10.8	7.8
	Total	20.4	32.9	29.0	9.4	7.7
The commercials	**Jr. High**	30.3	25.7	28.0	7.4	8.6
	Sr. High	23.4	25.6	25.9	11.7	13.3
	Total	25.2	25.6	26.8	10.0	11.2
The hosts of Channel One	**Jr. High**	25.4	42.4	22.0	3.4	6.8
	Sr. High	25.8	38.7	22.5	5.1	7.8
	Total	25.6	40.0	22.3	4.4	7.3
The adult reporters	**Jr. High**	20.8	47.9	21.4	4.0	5.8
	Sr. High	23.2	41.2	27.1	4.9	3.6
	Total	21.7	42.7	24.6	4.6	4.2
The student reporters	**Jr. High**	31.0	42.5	19.5	1.7	5.2
	Sr. High	29.6	35.7	23.2	7.6	3.9
	Total	29.8	37.3	21.5	5.4	4.2
The celebrity reporters	**Jr. High**	31.2	40.5	20.6	2.9	4.6
	Sr. High	27.5	38.5	21.4	7.6	4.8
	Total	28.1	38.8	20.8	6.0	4.7
The overall quality of the presentation	**Jr. High**	29.9	44.1	19.2	2.3	4.5
	Sr. High	26.2	45.2	21.1	3.9	3.6
	Total	27.5	44.6	20.2	3.3	3.8

TABLE 4
THE TEACHERS' DEGREE OF ATTENTIVENESS AND THE PERCEIVED EDUCATIONAL VALUE OF CHANNEL ONE
(PERCENTAGE OF YES RESPONSES, n = 33)

TOPIC	QUESTION	PERCENT
ATTENTIVENESS	Do you typically watch the Lead Story segment?	100.0
	Do you typically watch the Focus segment?	87.9
	Do you typically watch the Feature segment?	100.0
	Do you typically watch the Pop Quiz segment?	93.9
	Do you typically watch the End Piece segment?	87.9
	Do you typically watch the commercials?	42.4
PERCEIVED EDUCATIONAL VALUE	Is the information on Channel One generally used in classroom discussion?	57.6
	Is the information on Channel One generally useful in your out of school activities?	63.6
	Does Channel One provide new ideas to think about?	87.9
	Do you ever ask questions about the information shown on Channel One?	78.8
	Do you ever seek out more information about a topic shown on Channel One?	42.4
	At times, does Channel One relate to what you are currently studying in class?	78.8
	Does the information on Channel One make the students more aware of other cultures?	100.0
	Does Channel One provide the students with positive role models?	97.0

TABLE 5
QUALITY OF THE PRESENTATION OF CHANNEL ONE
(PERCENTAGE OF GRADE GIVEN TO EACH ITEM)
n = 33

ITEM	PERCENTAGE OF GRADE				
	A	B	C	D	F
The ability of Channel One to effectively communicate the information to viewers	60.6	36.4	3.0		
The style of graphics used	57.6	42.4			
Colors used during Channel One	66.7	27.3	6.1		
Maps and charts	69.7	27.3			
On-screen lettering	69.7	27.3	3.0		
Type of music used	51.5	30.3	12.1		
Loudness of music used	36.4	45.5	18.2		
Pacing of Channel One	33.3	51.5	15.2		
Visual excitement	45.5	45.5	3.0	3.0	3.0
The commercials	9.1	45.5	33.3	9.1	3.0
The hosts of Channel One	42.4	39.4	15.2	3.0	
The adult reporters	42.4	45.5	12.1		
The student reporters	42.4	45.5	12.1		
The celebrity reporters	42.4	48.5	9.1		
The overall quality of the presentation	63.6	33.3	3.0		

Title:

An Advance Toward Instructional Management: Prescriptive Knowledge Base of Learner Control

Author:

Jaesam Chung

An Advance toward Instructional Management: Prescriptive Knowledge Base of Learner Control

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Research Background

Learner control is widely believed to be a highly desirable feature of interactive learning systems because learner control allows learning to be individualized to each learner's needs. Learner control of instruction is intuitively appealing since it is assumed that learners will be more motivated if allowed to control their own learning.

However, research findings regarding the effects of learner control have been inconclusive, but more frequently negative than positive (Carrier & Sales, 1987; Steinberg, 1977; Tennyson, 1980; Ross & Morrison, 1989). Whereas learner control of instructional options has a great deal of intuitive appeal, and an enormous amount of computer-based program design has been carried out, much of research contradicts unrestricted learner control (Hannafin & Peck, 1984).

These negative findings may occur because many students, especially low achievers, lack the knowledge and motivation to make appropriate decisions regarding such conditions as pacing, sequencing of content, use of learning aids, and amount of practice. These negative findings may also exist because most learner control strategies employed in research have been insufficient, piece-meal, or narrow.

Teachers and instructional designers may require more systematic guidelines for implementing effective learner control in real world situations. A comprehensive, integrated, diverse, prescriptive, and specific theory/model of learner control that is viable for the interactive learning systems may lead to more effective implementation of learner control.

Research Questions

- What types of learner control are available in learning situations?
- What are the condition variables and the outcome variables when learner control types are considered as the method variable?
- How can educators and instructional designers identify the functional relationship between learner control and learner's cognitive development, between learner control and learning domains, and between learner control and learner's motivation?
- What can be done to ensure that learners will be able to effectively control and regulate their own learning in different instructional systems including non-individualized systems, individualized systems, intelligent learning systems, and hypermedia systems?

Research Procedure

This study reviews a variety of literature (both empirical and theoretical) relevant to "learner control." Learner control strategies reviewed by the researcher are analyzed and classified by the Conditions-Methods-Outcomes [C-M-O] paradigm (Reigeluth, 1983).

In this research, a variety of learner control methods (including content control, sequence control, pace control, display control, internal processing control, conscious cognition, metacognition, intelligent advisor, advisement strategy, etc.) are identified and integrated. This study inductively integrated the current knowledge base concerning learner control into a prescriptive form that would be useful to instructional designers and teachers. This study prescribed the "smorgasbord"of individual learner control strategies to cope with individual learning and instructional situations, as does Keller's ARCS model of motivational design (Keller & Kopp, 1987).

Results

The current instructional prescriptions of learner control are composed of: (1) three instructional outcomes; (2) three categories of instructional condition variables; and (3) five or more types of method variables.

Insert Figure 1 (Variables of Learner Control) about here

Instructional Outcomes

Instruction is judged by its effectiveness, efficiency, and appeal in the context of instructional management (that is, learner control). Reigeluth (1979, 1983) classifies learner outcomes into three categories: effectiveness, efficiency, and appeal of the instruction. Four important aspects of the effectiveness of instruction are the accuracy ("error rate"), the speed ("performance efficiency"), the degree of transfer, and the length of retention. The efficiency of instruction is usually measured by the effectiveness divided by the student time and the cost of instruction. The appeal of instruction is measured by learner's appreciation and desire for more.

Instructional Conditions

The selection of specific learner control strategies is determined by three sets of condition variables: (1) learner characteristics; (2) learning objectives (or domains); and (3) learning/instructional systems. Learning domains are usually considered constraint and constraint can be a condition variable. Learning systems are frequently regarded as a method variable, but in this study, they are only part of learning environment (i.e., condition variable)

The learner characteristics involve the learner's cognitive developmental stage (readiness), motivation, task persistence, aptitude, ability, prior knowledge, metacognition, age, etc.

Learning objectives (or domains of learning) are also a crucial condition variable (constraint) of learner control. Gagné (1985) classifies human learning domains into five categories: intellectual skills, verbal information, cognitive strategies, motor skills, and attitudes. Bloom's (1961) three domains (cognitive, affective, and psychomotor) and Merrill's (1983) performance-content matrix (remember, use, and find; fact, concept, procedure, and principle) are good classifications of learning domains. Reigeluth (1989) suggests several types of learning including memorization, understanding, skills application, generic skills, and affective learning.

Instructional/learning systems also seem to be an integral part of learner control. We need to tailor learner control methods to individual instructional/learning systems. Instructional/learning systems include non-individualized system, individualized instructional systems (such as traditional CAI, TICCIT), intelligent learning systems (such as ICAI), and Hypermedia systems.

Instructional Methods

Method variables of learner control in current theory include Merrill's (1984) notion of content control, sequence control, pace control, display (strategy) control, internal processing control such as conscious cognition and metacognition, and intelligent advisor (Merrill, Li, & Jones,1990). In addition, Tennyson's (1985) advisement strategy and Reigeluth's (1979, 1983) notion of macro-level control (such as sequencing, selecting, summarizing, synthesizing), user control, and system control can also be considered as learner control strategies.

Prescriptions of Learner Control

Considering condition, outcome, and method variables of learner control altogether, instructional prescriptions of learner control were contrived in a smorgasbord fashion. Below is a list of learner control prescriptions which, based on the conditions, will optimize the desired instructional outcomes.

A. (CONTENT CONTROL over segments, lessons, units, and courses) Provide learners with more opportunities to make content selection as learners grow older.

e.g.) - junior high school level -- a choice among 2-3 alternatives in addition to required courses
- university level -- almost unlimited options

A1 If one is good at content, one can use options effectively Selection of topic is dependent on the learner's competencies in the topic. (Judd, Bunderson, & Bessent, 1970; Sasscer & Moore, 1984).

A2 Learner control is likely to work well compared to program control when higher order skills rather than factual information are being taught, and when the content is familiar to learners (Hannafin & Peck, 1988). This view supports Reigeluth's (1989) point that, to some extent, user (learner) or system (program) control will be determined by instructional objectives.

B. (SEQUENCE CONTROL) Offer opportunity for student to sequence the objectives within a particular course of instruction in any order IF the student so desires.

B1 DON'T use sequence control WHEN the objectives or contents (segments, lessons, and units of instruction) are sequenced, as in linear delivery systems (lecture, videotape, slide presentations, or movies) which make the reordering of content components difficult.

B2 Use sequence control in self-paced individualized materials (such as workbooks, textbooks, etc) which enable learner to do.

B3 Learners use prior knowledge to determine their instructional sequence (Mager, 1961; Mager & Clark, 1963).

C. (PACE CONTROL) Offer the opportunity to study a given unit or lesson as long as needed IF learners are using individualized instruction or self-paced instruction (Merrill, 1984).

C1 Keep moderate level of control over learning time to make improve performance of learner (Tennyson, Park, & Christensen, 1985).

C2 If learners get coached practice on self-directed study, then they can increase their performance and motivation, and can reduce instruction time (Campbell & Terry, 1963).

D. (DISPLAY or STRATEGY CONTROL) Present a single subject-matter idea.
a general statement (generality) or
a specific example

D1 WHEN students are provided a mechanism for selecting and sequencing those displays which they feel are required to understand a given objective, at least three types of display control are involved.

- selection of the number of displays required for perceived mastery
- control of sequence of different types of displays
- selection of various displays.

D2 Use display selection and sequence control in TICCIT system by means of rule, example, and practice button.

E. (INTERNAL PROCESSING CONTROL) Use a variety of internal processing strategies WHEN the learner interacts with the presentation of the instruction.

Interaction of these internal processes with the stimulus materials will help the learner perform effectively and efficiently.

E1 (CONSCIOUS COGNITION) In order to encode the information presented by a given display, learner should use mental processes.

In order to compensate for inadequate display, learner should appropriately select the cognitive processing activities.
rehearsal, repetition, paraphrasing,
imaging, encoding via mnemonic,
exemplifying, and covert practice.

Use the introspective interview with learners in order to obtain a record of the processing attempted for each display.

E2 (METACOGNITION) In order to guide their interaction with an instructional system being used, learners should use the "how to study or learn" model.

When learners are taught to use more appropriate methods, they acquire not only subject matter but also some internal theory about "how to learn".

Use the introspective interview technique in order to assess the mata-cognitive models being used by a student.

F. (ADVISOR STRATEGIES in new CDT) Use an Intelligent Advisor in order to determine if a given learner needs a particular type of interaction ("transaction"), which was not originally included in the transaction frame sets of the course.

G. Individual Difference

G1 If high-ability students are put under learner control group and low-ability students are put under external control (Program Control), the performance of both sides will be improved. (Greene, 1976)

G2 Student learning should be individualized because students differ in the way they use instructional options in learner control conditions (Mager & McCann, 1961: Seidel, Wagner, Rosenblaff, Hillelsohn, & Stelzer, 1978)

G3 Instructor should not insist on his/her instructional sequences because learners often prefer different sequences. The most meaningful sequences for the students were different from those used by the instructors. (Mager, 1961; Mager & Clark, 1963)

- Learner sequences: "from a whole to a more complex whole"
- Instructor sequence: "from the part to the whole"

H. Prior Knowledge

H1 If learners have prior knowledge, they tend to select more content option than those without such knowledge (Nelson, 1985).

H2 Learners are likely to enter a learning situation WHEN they have a significant amount of relevant knowledge. (Mager & Clark, 1963)

H3 Use Advance Organizer to improve the effectiveness of learner control (Mayer, 1976).

H4 For learners with a low domain knowledge base, program control is superior to learner control. The difference diminishes for those with a high domain knowledge base. Learner's self-judging ability is contingent on the level of prior domain knowledge (Lee & Lee, 1991).

I. Motivation/Attitude/Feedback

I1 Provide feedback on cumulative performance in order to increase learner control effectiveness. (Schloss, Wisniewski, & Cartwright, 1988).

I2 Provide encouragement, advice, and monitoring strategies in order to improve effectiveness of learner control and student 'on-task' time. (Carrier, Davidson, & Kalweit, 1986)

I3 In order to increase student motivation and attitude of learning, use learner control strategies (Mager, 1961; Newkirk, 1972).

J. Learning Phases:

Use program control instead of learner control for knowledge acquisition. Meanwhile, use learner control instead of program control in the knowledge review phase (Lee & Lee,1991).

K. Self-Assessment/Learning Strategy

K1 Develop learning skills in order to justify initiatives for creating learning environment. (Derry & Murphy, 1986)

K2 Use self-instruction in order to initiate, plan, organize, monitor, and regulate own learning process. (Weiner & Kluwe, 1987)

K3 In order to make good use of learner control, conduct self-assessment. However, young students have difficulty assessing their own performance or their en-route comprehension. (Garhart & Hannafin, 1986)

L. Instructional/Learning Systems

If one understands and manages learner control well, one will feel comfortable with the current conception of intelligent tutoring systems. (Duchastel, 1986).

Conclusion & Implication

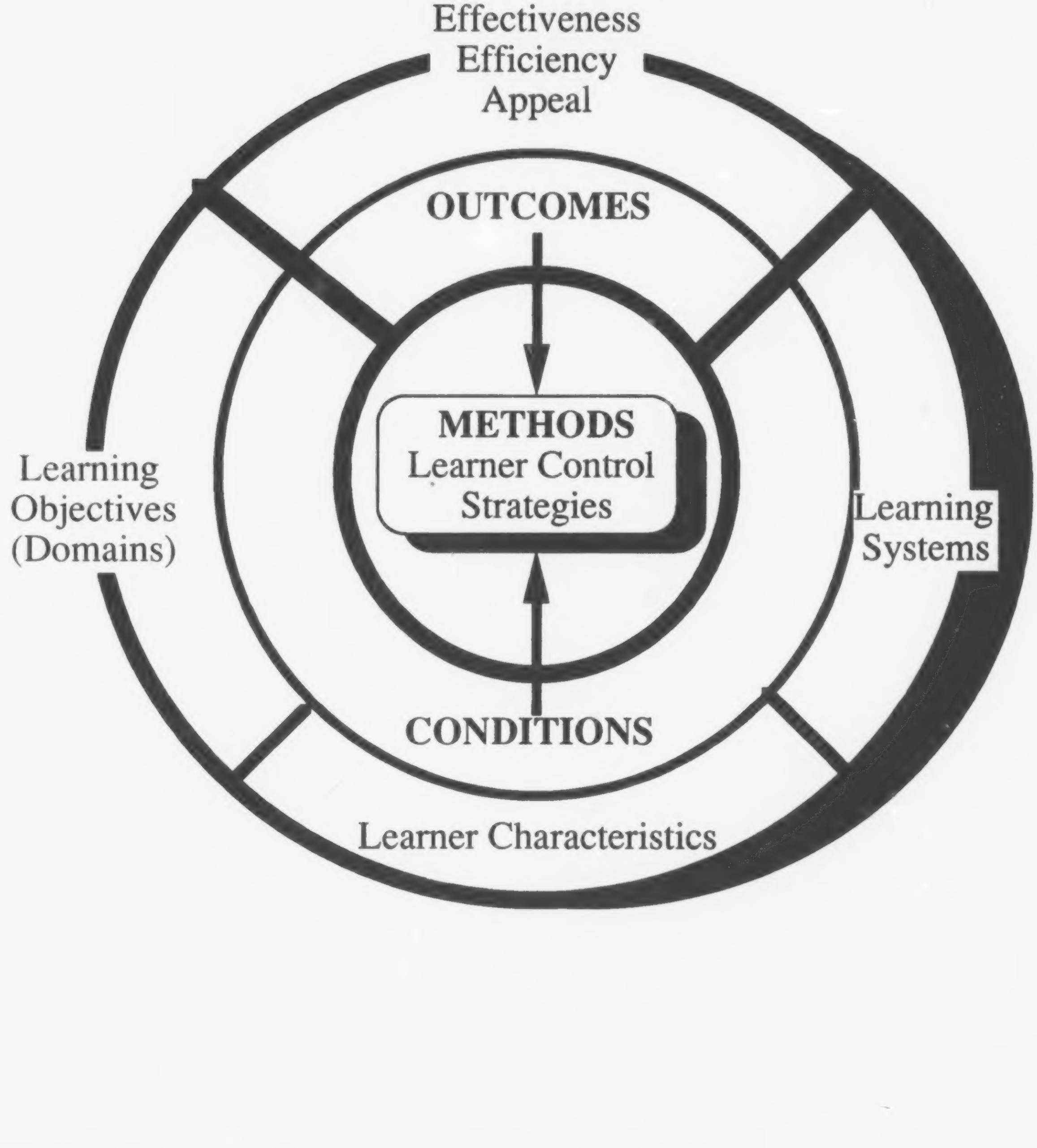
We discuss learner control as one of the main issues in instructional management and the importance of effectiveness and efficiency in the context of instructional/learning systems. Instructional prescriptions of learner control are developed in a smorgasbord fashion.

Teachers and instructional designers may have the chance to consider the functional relationship between learner control and cognitive development of the learner, between the learner control and types of learning (or learning domains), and between learner control and learner's motivation. They can use this prescriptive knowledge base of learner control in order for their students to maximize the effectiveness and efficiency of a given learning situation.

At this point, we should look into our challenges for the future. All instruction involves some learner control. Our challenge is not whether or not learner control should be used, but rather how to maximize the learner's ability to use the learner control available. Every student has some type of internal "how to learn" model which directs his/her learner control. Thus, the most promising area for future exploration is to help learners to develop internal adaptive models which direct their use of appropriate internal processing. We should seek to identify the nature of learner control in every instructional situation and know more about the types of conscious cognitive control which may be appropriate for different outcomes and for different displays. Then, the student who has the most choices available will be best able to maximize the effectiveness and efficiency of a given learning situation.

From a different view, we can provide three suggestions here for tomorrow's learner control research. First, outcomes considered within learner control research should include the development of effective learning strategies, the continuing motivation to learn, and long range achievement. Second, explore ways in which advisement can be offered to assist individuals in the use of learner-controlled features and regulation of their own learning. Third, the relationship between the provision of learner control and student perception of control within instruction should be considered.

Figure1. Variables of Learner Control


Effectiveness
Efficiency
Appeal
OUTCOMES
METHODS
Learner Control
Strategies
Learning
Objectives
(Domains)
Learning
Systems
CONDITIONS
Learner Characteristics

Reference

Bloom, B. S. (Ed.). (1956). Taxonomy of educational objectives, Handbook I: cognitive domain. New York: David Mckay.

Campbell, V. & Terry, D. (1963). Self-direction in programmed instruction: Effects on learning in low ability student. Palo Alto, CA: American I nstitute for for Research, July, 1963, Technical Report, AIR-D10-7/63-TR.

Carrier, C. A., Davidson, G. V., & Kalweit, C. M. (1986). Instrructional options and encouragement effects in a microcomputer-delivered concept lesson. Journal of Educational Research, 79(4), 222-229.

Carrier, C. A. & Jonassen, D. H. (1988). Adapting courseware to accommodate individual differences. In D. H. Jonassen (Ed.), Instructional designs for microcomputer courseware. Hillsdale, NJ: Lawrence Erlbaum Associates.

Derry, S.& Murphy, D. (1986). Designing systems that train learning ability: from theory to practice. Review of Educational Research, 56(1), 1-39.

Duchastel, P. (1986). Intelligent computer assisted instruction systems: The nature of learnercontrol. Journal of Educational Computing Research, 2(3), 379-393.

Gagné, R. M. (1985). The conditions of learning and a theory of instruction (4th ed.). New York: Holt, Rinehart and Winston.

Garhart, C. & Hannafin, M. (1986). The accuracy of cognitive monitoring during computer-based instruction. Journal of Computer-Based Instruction, 13(3), 88-93.

Greene, J. C. (1976). Choice behavior and its consequences for learning: An anti-study. Doctoral Dissertation, Stanford University. Dissertation Abstracts International, 2740-A- 2741-A.

Hannafin, M. J. & Peck, K. L. (1988). The design, development, and evaluation of instructional software. New York: Macmillan.

Keller, J. & Kopp, T. (1987). An application of the ARCS Model of Motivational Design. In C. M. Reigeluth (Ed.), Instructional theories in action. Hillsdale. N.J.: Lawrence Erlbaum Associates.

Lee, S. & Lee, Y. (1991). Effects of learner-control versus program-control strategies on computer-aided learning of chemistry problems: For acquisition or review? Journal of Educational Psychology, 83(4), 491-498.

Mager, R. (1961). On sequencing of instructional content. Psychological Reports, 9, 405-413.

Mager, R. & Clark, C. (1963). Explorations in student-controlled instruction. Psychological Reports, 13, 71-76.

Mager,R. & McCann, J. (1961). Learner-controlled instruction. Palo Alto: Varian Association.

Mayer, R. (1976). Can advance organizers influence meaningful learning? Review of Educational Research, 49(2), 371-383.

Merrill, M. D. (1983). Component display theory. In C. M. Reigeluth (Ed.), Instructional-design theories and models: An overview of their current status (pp. 279-333). Hillsdale, NJ: Lawrence Erlbaum Associates.

Merrill, M. D. (1984). What is learner control? In Bass, R. K. & C. D. Dills (Eds.) Instructional Development: The state of the art, II. Dubuque,IA: Kendal/ Hunt.

Merrill, M. D., Li, Z., & Jones, M. (1990). Second generation instructional design, Educational technology, 30(2).

Nelson, D. S. (1985). An investigation into the effects of learner control options on patterns of learning strategies. Doctoral Dissertation, Western Michigan University.

Newkirk, R. (1972). A comparison of learner control and machine control strategies for computer-assisted instruction. Programmed Learning and Educational Technology, 10 (2), 82-91.

Reigeluth, C.M. (Ed.). (1983). Instructional-design theories and models: An overview of their current status. Hillsdale, NJ: Lawrence Erlbaum Associates.

Reigeluth, C. M. (1979). TICCIT to the future: Advances in instructional theory for CAI. Journal of Computer-Based Instruction, 6(2), 40-46.

Reigeluth, C. M. (1989). Educational technology at the crossroads: New mindsets and new directions. Educational Technology Research and Development, 37(1),67-80.

Ross, S. M. & Morrison, G. M. (1989). In search of a happy medium in instructional technology research: Issues concerning external validity, media replications, and learner control. ETR&D, 37(1), 19-33.

Schloss, P., Wisniewski,L., & Cartwright,G. (1988). The differential effect of learner control and feedback in college students' performance on CAI modules. Journal of Educational Computing Research, 4(2), 141-150.

Seidel, R., Wagner,H., Rosenblaff,R., Hillelsohn,M., & Stelzer, J. (1978). Learner control of instructional sequencing within an adaptive tutorial CAI environment. Instructional Science, 7, 37-80.

Steinberg, E. R. (1977). Review of student control in computer-assisted instruction. Journal of Computer-Based Instruction, 3(3), 84-90.

Tennyson, R. D. (1980). Instructional control strategies and content structure as design variables in concept acquisition using computer-based instruction. Journal of Educational Psychology, 72(4), 525-532.

Tennyson, R. D. (1981). Use adaptive information for advisement in learning concepts and rules using computer-assisted instruction. American Educational Research Journal, 18(4), 425-438.

Tennyson, R., Park, O., & Christensen,D. (1985). Adaptive control of learning time and content sequence in concept learning using computer-based instruction. Journal of Educatioonal Psychology, 77(4), 481-491.

Weiner, F. & Kluwe, R. (1987). Metacognition, motivation, and understanding. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Title:

The Effects of Different Forms of Computer-Mediated Feedback on Lesson Completion Time

Author:

Roy B. Clariana

The effects of different forms of computer-mediated feedback on lesson completion time

by Roy B. Clariana

Overview

This study considered the effects on lesson completion time of four forms of immediate feedback. Thirty-two low-ability eleventh grade students were randomly assigned to one of four feedback treatments. Every student received four social-studies reading passages printed on regular U. S. Letter size paper, with one passage per page. Each passage averaged 350 words in length. Eight 4-alternative multiple choice questions were presented by computer with each passage, with one question per screen. One of the following four feedback forms was provided for each treatment condition. Students received either knowledge of correct response feedback (KCR), which provided the correct alternative after the students' first attempt or KCR with second try (KCR second try), which allowed the student to try twice before the correct answer was provided (Clariana, Ross, & Morrison, 1991; Dempsey & Driscoll, 1989; Noonan, 1984). [Note, if students are correct on their first try, then these two forms are not different. These low-ability students averaged 30% correct during the lesson, suggesting that about 70% of the items were delivered as the alternate treatments.] The KCR and KCR second try conditions were completely crossed with two levels of context termed Full and Focus (Sassenrath & Yonge, 1969; Sturges, 1969; Winston & Kulhavy, 1988). Full-context feedback (Full) presented the stem, distractors, and the correct alternative, while Focused-context feedback (Focus) presented only the stem and correct alternative, the distractors were not shown.

Summary of Achievement Results

Achievement data results from this study are published in detail in Clariana (1990). To summarize the achievement findings, the KCR treatment posttest mean was significantly larger than the KCR second try treatment posttest mean, $F(1,28) = 4.561$, $p = .041$. No difference was shown for Full and Focus contexts or for the interaction of feedback and context.

Feedback and Information Processing

The simple assumption was made that more feedback information per lesson would translate into more time in the lesson. Thus, it was hypothesized that a significant time difference (i.e., an interaction) would occur between the KCR-Focus group (with the least feedback information) and the KCR second try-Full group (with the most feedback information). Support for this hypothesis would provide support for the current information processing model of feedback function.

Results

The time data were analyzed by a two between ANOVA design which included feedback (KCR, KCR second try) and context (Full, Focus). ANOVA results of total lesson time data did not reveal the hypothesized interaction (see Tables 1 and 2). The main effect for feedback [$F(1,28) = 1.933$] and the interaction of feedback and context [F(1,28) = 0.081] were not significant. The main effect for context was significant, F(1,28) = 9.181, p = .005. Examination of the context treatment means showed that, unexpectedly, the students took more time to complete the Focus treatments (x = 2594 seconds) than to complete the Full treatments (x = 1893 seconds).

Table 1
ANOVA Summary Table.

source	df	SS	MS	F	p
Treatment	1	827219.5	827219.5	1.933	0.175
Context	1	3929105.3	3929105.3	9.181	0.005 *
Treatment x Context	1	34650.3	34650.3	0.081	0.778
Error	28	11982665.1	427952.3		

Table 2
Time spent on Items and on Feedback, in seconds.

Treatments	Items (screens)	Feedback - 1st try	Feedback - 2nd try	Feedback Totals	Lesson Totals
Full - KCR	1548	225	--	225	1773
Full - KCR 2nd try	1681	129	203	332	2013
Focus - KCR	2260	145	--	145	2405
Focus - KCR 2nd try	2374	112	297	409	2783

Discussion

The expected simple linear relationship that more feedback information will mean longer lesson time was not confirmed. As anticipated, the learners did spend more time in the KCR second try treatment (x = 2398 seconds) than in the KCR treatment (x = 2089 seconds), though this difference was not significant. Most of the time difference between the KCR and KCR second try groups is explained by the time spent on second tries (x = 250 seconds). Interestingly, the learners in this study who knew they would receive a second try (i.e., KCR second try condition) spent less time on the first feedback presentation and considerably more time on the second feedback presentation, relative to the one try (i.e., KCR) group.

Contrary to expectation, learners spent significantly more time in the Focus treatment (x = 2594 seconds) than in the Full treatment (x = 1893 seconds). Why should the Focus condition, with less information, take longer to complete? First, the feedback form may have altered how the students used the feedback. Learners in the Full condition spent on average 279 seconds on feedback while students in the Focus condition spent on average 277 seconds. However, examination of total feedback time means shows that an interaction occurred (see Figure 1). Learners in the Focus condition, when given only one try (the KCR condition), examined feedback the least, as might be expected. However, students in the Focus condition that were given a second try examined the feedback that was given after their second try for a considerably longer time. It cannot be determined in this study whether this additional time should be attributed to reading feedback, the passage, or both. It is likely that the learners were rereading the text passage. Giving learners a second round of feedback may cause them to reread text passages.

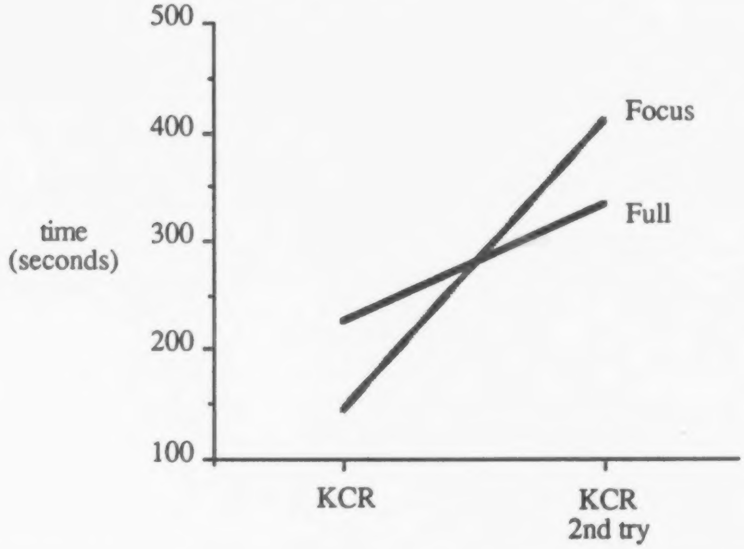


Figure 1. Line graph of total time in feedback for each treatment.

Was reading time equally distributed over each question? The answer is no. Since the main effect Context was significant, a line graph of the average time for each screen for Full and Focus context is shown in Figure 2. Note the four reading passages labelled passage 1 through passage 4. There are 36 distinct time points, one for each screen. The first screen for each passage was a brief instruction screen which indicated which passage the student should read to answer the following questions. The remaining eight points for each passage show the average time for each question, which includes the feedback given with that question.

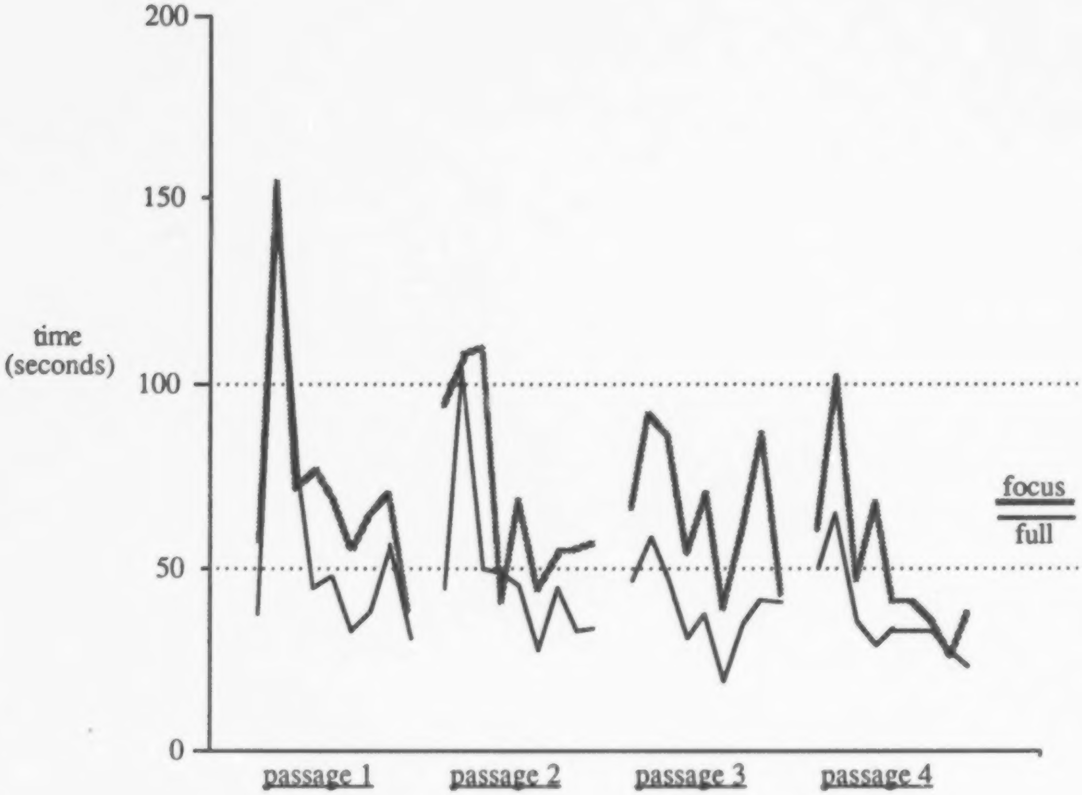


Figure 2. Average time per screen for the Full and Focus Treatments.

Several trends are shown in Figure 2. First, the students spent a relatively long amount of time during the instruction screen (which contained one short sentence) and then more time with the first question in the sequence. This pattern was repeated with each succeeding passage. Probably, the students read the passage initially and then in more detail after the initial question. Therefore, it is possible that the first few question in a series of questions may direct or influence the student's text processing approach (i.e., meta-level) toward that text passage. If so, previous adjunct question research may be confounded by the possibility of question order effects. Future research should address this possibility. Practically, this suggests that Instructional Designers may need to pay close attention to the first question in a series of questions, since it may function to direct the student's processing of the passage. Also, learners in all four treatment conditions spent more time with the first passage than with the succeeding passages (*passage 1*: 579 seconds; *passage 2*: 525 seconds; *passage 3*: 473 seconds; *passage 4*: 389 seconds), even though the passages were similar in length and difficulty (see Figures 2 and 3). Thus, the initial passage may itself serve an orienting function.

Second and more importantly, feedback context may have altered how the learners used supporting materials (see Figure 3). Note that learners in the Full condition spent considerably less time with each succeeding passage, while learners in the Focus condition maintained a relatively high average amount of time on the first three passages, which then dropped with passage four. Learners in the Focus treatment could be described as "persisting" throughout the lesson, both with individual items and with succeeding passages.

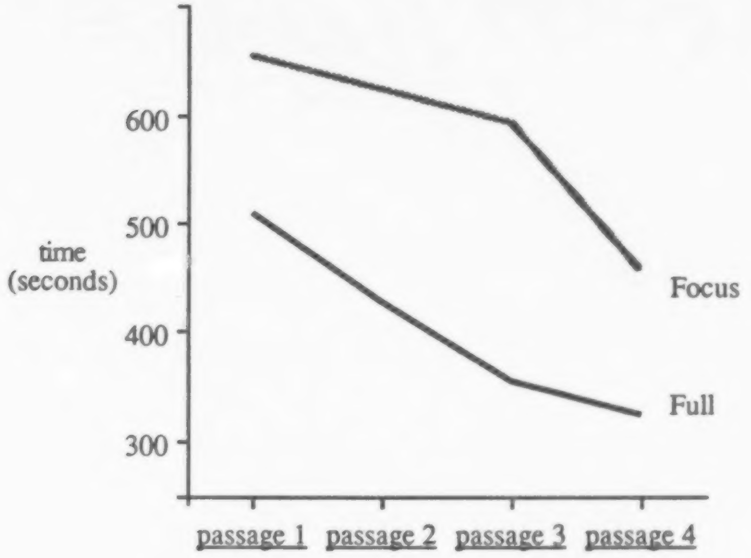


Figure 3. Average total time per passage for the Full and Focus Treatments.

Time data were collected both during the lesson and during the achievement posttest. Interestingly, a high correlation was observed between the lesson and posttest completion times [*R*=0.60, *F*(1,31)=16.866, *p*=0.0003]. Two alternate explanations occur. *One*, learners have a characteristic way or rate of responding during computer instruction, or *two*, the lesson treatments established an episodic, conversational, or rhythmic response pattern that carried over to the posttest. In this study, probably both are occurring. Either alternative has serious implications for research involving time or rate variables, since confounding is likely to occur in studies that do not control these variables. Future research should address these alternative models.

In summary, the significant time difference observed for Focus over Full feedback is due to increased persistance both with each item in a series and with each succeeding passage, especially with later passages in the sequence (see Figures 2 and 3). Does less information in the Focus condition cause the student to spend more time with the reading passage relative to the Full condition? Alternately, persistence may be an individual learner characteristic, thus random assignment in this study failed with most "persisters" falling in the Focus group.

If feedback form does in fact alter learners' responses to text passages, then current information processing models that view feedback from a "quantity" of information viewpoint seem inadequate to explain this finding. Different forms of feedback may qualitatively alter a learner's approach to supporting lesson material. Additional research should consider the possibility of qualitative as well as quantitative effects of feedback.

References

Clariana, R. B. (1990). A comparison of answer until correct feedback and knowledge of correct response feedback under two conditions of contextualization. Journal of Computer-Based Instruction, 17(4), 125-129.

Clariana, R. B., Ross, S. L., & Morrison, G. R. (1991). The effects of different feedback strategies using computer-assisted multiple-choice questions as instruction, Educational Technology Research and Development, 39(2), 5-17.

Dempsey, J. V., & Driscoll, M. P. (1989). The effects of four methods of immediate corrective feedback on retention, discrimination error, and feedback study time in computer-based instruction. A paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Noonan, J. V. (1984). Feedback procedures in computer-assisted instruction: Knowledge of results, knowledge of correct response, process explanations, and second attempts after explanations. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Sassenrath, J. M., & Yonge, G. D. (1969). Effects of delayed information feedback and feedback cues in learning on delayed retention. Journal of Educational Psychology, 50, 174-177.

Smith, P. L. (1988). Toward a taxonomy of feedback: Content and scheduling. A paper presented at the Annual Meeting of the Association for Educational Communications and Technology, New Orleans, LA.

Sturges, P. T. (1969). Verbal retention as a function of the informativeness and delay of information feedback. Journal of Educational Psychology, 50, 11-14.

Winston, K. S., & Kulhavy, R. W. (1988). Feedback form and distribution with written instruction. A paper presented at the Annual Meeting of the Association for Educational Communications and Technology, New Orleans.

Title:

The Effects of Different Feedback Strategies Using Computer-Administered Multiple-Choice Questions as Instruction

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Abstract

The present study investigated the effects of using different forms of material. The basic design consisted of two conditions of instructional support (text and questions vs. questions only), two testings (immediate vs. retention), five levels of similarity between lesson and posttest questions, and five feedback conditions: Knowledge of Correct Response (KCR), delayed KCR, Answer Until Correct (AUC), questions only (no feedback), and no questions. Results showed significant benefits for feedback over no-feedback, with AUC becoming more advantageous and delayed feedback less so as lesson-posttest question similarity decreased. Also, with decreased question similarity and the availability of supporting text, overall feedback effects tended to decrease. The results are discussed in terms of the information processing effects of the different feedback forms, a factor that CBI designers often fail to exploit in planning feedback conditions.

The Effects of Different Feedback Strategies Using Computer-Administered Multiple-Choice Questions as Instruction

The use of feedback is a critically important and often neglected attribute in computer-based instruction (CBI). Feedback promotes learning by providing students with information about their responses. Through its interactive capabilities, CBI increases the range of feedback strategies that can be efficiently achieved. Specifically, when incorporated in multiple-choice testing, three common forms include (a) knowledge of response feedback (KOR or KR), which indicates that the learner's response was correct or incorrect; (b) knowledge of correct response feedback (KCR), which identifies the correct response; and (c) elaborative feedback, which identifies the correct response while providing additional explanations (Merrill, 1985).

As would be expected, these forms of feedback may not be equally effective. Several studies have shown KCR to be superior to KOR, and KOR to be superior to no feedback (Gilman, 1969; Kulhavy, 1977; Travers, Van Wagenen, Haygood, & McCormick, 1964; Waldrop, Justin, & Adams, 1986). However, based on his own research and a meta-analysis of studies, Schimmel (1983; 1986) concluded that this hierarchy of immediate feedback types is not so well established. Evidence also suggests that elaborative forms of feedback often produce no significant improvement over KCR, but require a considerable development and implementation cost (Merrill, 1985, 1987; Spock, 1987). Despite years of research, the types of situations in which different feedback forms tend to operate most effectively are still not understood. Part of the reason may be a failure to account adequately for the influences on results of task and learner characteristics as well as the cognitive (as opposed to behavioral) impact of the different feedback treatments employed (see Hannafin & Rieber, 1989). Kulhavy & Stock (1989) further attribute the lack of understanding of feedback effects to the reinforcement emphasis of the operant conditioning paradigm that predominated research and theory for many years. In their current model, they stress the cognitive implications of feedback effects on information processing, while indicating that systematic research illuminating such effects has been minimal.

Usually, feedback is provided to the learner after one response. However, using CBI, a learner may easily be allowed a second try with an item (Dempsey & Driscoll, 1989; Noonan, 1984) or may be required to continue to respond until the correct answer is selected (Pressey, 1926, 1950). The latter orientation is conventionally labeled answer-until-correct (AUC) feedback. Allowing unassisted multiple response tries has considerable intuitive appeal. AUC may engage learners in additional active processing following errors and also ensures that the last response is a correct one, a principle espoused over half a century ago in the contiguity theory of Edwin Guthrie (1935). Unfortunately, there have been relatively few controlled empirical studies to test this interpretation or whether, in general, allowing one response or requiring many responses to an item is more effective (Dempsey & Driscoll, 1989; Noonan, 1984). On the one hand, providing the correct answer after only one response may "short-circuit" learning (Schimmel, 1986). Alternatively, requiring a learner to answer until correct may be frustrating (Dick & Latta, 1970).

Feedback timing is another variable of interest (Hannafin & Reiber, 1989; Kulhavy & Stock, 1989). Feedback may be provided immediately after the learner's response or it may be delayed for either a set period of time or set number of responses, such as at the end of a test. From a recent meta-analysis, Kulik and Kulik (1988) concluded that immediate feedback was best for most learning situations, but delayed feedback was superior in "test-acquisition" studies, i.e., learning situations in which test questions are used as the instruction. Two interpretations are most commonly used to explain test-acquisition benefits. One is termed the interference perseveration hypothesis (Kulhavy & Anderson, 1972). This view holds that an incorrect response proactively interferes with an immediately provided correct response. Delaying the presentation of feedback allows learners time to forget their initial responses, thereby reducing proactive interference effects. However, if such is the case proactive interference should occur not only in test-acquisition studies but in any manipulation of immediate and delayed feedback. A possible explanation concerns the instructional support other than embedded questions that most lessons provide. Such support may consist, for example, of reading passages, pictures, outlines, overviews, or video-clips. This support may serve to make the the material more memorable and thus more resistant to proactive interference.

The second interpretation is based on the rationale that delayed feedback repeats the item presentation at the end of the lesson, thereby providing twice as much exposure than does immediate feedback (Kulik & Kulik, 1988). But if other forms of instructional support are included, such as the addition of a reading passage, the effects of the double exposure are likely to be mitigated. Delayed and immediate feedback would then produce comparable results. Both the interference and frequency-of-feedback views appear to provide valid explanations of feedback-timing effects and both are supported by research (More, 1969; Newman, Williams, & Hiller, 1974; Peeck & Tillema, 1978; Suber & Anderson, 1975). The role of text as instructional support for questions (i.e., test-acquisition vs. text-with-questions effects), however, has not been adequately investigated.

The literature on feedback also leaves questions unanswered regarding the relationship of lesson questions to posttest questions. Often, posttest questions are identical in form and wording to the lesson questions, a rote recognition condition that substantially restricts the degree to which results can be generalized to typical learning situations. Bormuth, Manning, Carr and Pearson (1970) demonstrated experimentally how posttest questions could be adapted from instructional reading passages to measure comprehension learning by transforming and paraphrasing text (also see Anderson, 1972). Using their approach, the present study was designed to compare the effects on learning of three types of feedback strategies (KCR, AUC, and delayed) applied to five levels of lesson questions differing in degree of relatedness to posttest questions. An additional variable was whether feedback treatments were presented with associated text passages or with no text (i.e., test-acquisition. Subjects were low-ability high school students enrolled in a summer preparatory program in science. The following hypotheses were tested.

1. The provision of feedback vs. no feedback would improve learning across all feedback strategies and questioning levels.

2. AUC feedback would become increasingly effective relative to other feedback forms as question level (disparity between lesson and posttest questions) increased, due to providing additional processing opportunities and review of the information to be learned.
3. The provision of text would become more facilitative as question level increased due to furthering understanding of the material through the provision of additional descriptions and explanations.

Method

Subjects and Design

Subjects consisted of 100 eleventh grade students enrolled in a five-week CBI summer enrichment program sponsored by Memphis Partners Incorporated. Memphis Partners selects students considered to be at-risk from all schools in the metropolitan area. All subjects voluntarily participated in this study which was described as an American College Test (ACT) preparation course. All subjects were black; their median age was 17. To qualify for the program, they needed to (a) be entering the 12th grade in the fall; (b) have low ACT scores (between 10 and 15); and (c) be described by their guidance counselors and teachers in a written recommendation as having academic potential for college, despite their low standardized achievement scores.

Subjects were randomly assigned to one of 10 treatment groups consisting of five feedback conditions (KCR, AUC, delayed KCR, questions only, and no questions) crossed with two conditions of instructional support (text and no-text). Within-subjects factors consisted of five question levels (verbatim-identical, inferential-identical, inferential-transformed, inferential-paraphrased, and transformed-paraphrased), and two testings (immediate and retention). The analytical design thus consisted of a 5(feedback) x 2(instructional support) x 5(question level) x 2(testing) mixed analysis of variance (ANOVA).

Prior to the start of the instructional phase of the study, all subjects were administered the ACT Natural Science Reading Test and the Nelson-Denny Reading Comprehensive Test Form E to assess treatment group equivalence. The former test is a measure of science knowledge, and the latter is a measure of reading ability. Analyses of pretest scores, using a 5(feedback) x 2(support) ANOVA, indicated no significant differences between treatment groups on either measure.

Instructional and Assessment Materials

Text passages. The reading materials were adopted from the ACT National Sciences Reading Test, 8223c. They included four text passages entitled "Solids," "Genetics," "Compressed Gas," and "Trojan Asteroids." The average number of words per passage was 350. All passages were presented in print form to allow subjects continual access to them during the lesson and to create a more realistic learning situation. Readability of the passages, using Dale-Chall (1948) and Flesch (1948) procedures, ranged from 10th grade to college.

Lesson and posttest questions. For each passage, 10 lesson questions were constructed. Because the instructional orientation of the ACT passages and achievement test (ACT sample Test 8223C) emphasized inferential learning (i.e., reasoning from the passage to solve a problem or application), it was decided to make 8 out of each 10 (80%) lesson questions inferential and the remaining two questions (20%) verbatim. Inferential questions required going beyond the specific text information to formulate an idea or concept not explicitly stated. Verbatim questions repeated the text passage word for word.

Each of 40 lesson questions was made parallel to an existing verbatim or inferential posttest question adapted from the _ACT Sample Test 8223c_. Posttest questions were then varied in form on a random basis for the purpose of assessing different levels of learning. For the inferential questions a 2(transformation) x 2(paraphrase) design matrix was used to achieve these levels. As will be described below, one factor was whether a structural _transformation_ or the original form of the corresponding lesson question was used; the other factor was whether _paraphrased_ wording or original wording was used. Specifically, _transformed_ posttest questions reversed the stem and the answer from the corresponding lesson question. To illustrate using a simple example, the question, "The capital of Arkansas is: (a) Little Rock (b) Memphis (c) Dallas" would be transformed to read: "Little Rock is the capital of (a) Arkansas (b) Tennessee (c) Texas." _Paraphrased_ questions were constructed to maintain the same structure and meaning as corresponding lesson questions, but using different words or phrasing.

These manipulations resulted in five levels of posttest questions. Table 1 illustrates the five question forms in relation to a lesson text segment containing tested content. Both lesson questions and posttest questions were administered on a WICAT System 300 microcomputer with 30 student stations. The five forms are summarized below:

1. _Verbatim-Identical_ (VI) tested verbatim learning using the same wording as the original text and the lesson questions.
2. _Inferential-Identical_ (II) tested inferential learning using similar wording as the text and the identical wording as the lesson questions.
3. _Inferential-Transformed_ (IT) tested inferential learning using similar wording as the text, but the question answer and stem were reversed relative to lesson questions.
4. _Inferential-Paraphrased_ (IP) tested inferential learning using different words and phrasing relative to the text and the lesson questions.
5. _Transformed-Paraphrased_ (TP) tested inferential learning using both a transformed structure and paraphrasing.

Insert Table 1 about here

Reliability of the posttest and lesson questions was assessed employing 94 high school students (47 for each question set). Split-half reliability, using the Spearman-Brown formula, was .66 for the posttest set and .85 for the lesson set.

Text and Feedback Treatments

Manipulation of the text variable involved either providing or not providing the passages to read during the lesson. The feedback variable consisted of three feedback forms and two no-feedback control conditions (questions without feedback and no questions). When presented without text, the no-questions variation represented a pure control condition in which students were administered the two posttests without receiving prior instruction. Each of the three feedback conditions is described below.

1. Knowledge of correct response (KCR). This condition, which was patterned after that used by Dempsey (1988; also Tait, Hartley, & Anderson, 1973), informed the learner of the correct answer after each response. Specifically, following a correct response, the word "RIGHT" was displayed at the bottom of the computer screen. Following an incorrect response, the word "WRONG" was displayed with the correct answer designated by an arrow. The learner was instructed to type the letter of the correct answer to continue.

2. Answer until correct (AUC). AUC, based on Dempsey (1988), provided the same feedback as KCR following correct responses. However, following the first incorrect answer to a given question, the prompt, "NO TRY AGAIN " was displayed at the bottom of the screen. The learner then made a second try, which if correct was followed by the usual "RIGHT," and if incorrect was followed by "WRONG" along with the instruction to type in the letter of the correct response (as designated by the arrow). Thus AUC was identical to KCR, except for the second try given following an initial error response.

Delayed feedback. This condition provided KCR-type feedback at the conclusion of all four lesson sections by individually presenting the 40 questions in original order, with the correct answer for each designated by an arrow. Separate from this concluding feedback display, an additional design consideration was whether to provide any immediate feedback to indicate the accuracy of responses. Given the difficulty and technical nature of the subject matter, we reasoned that the absence of such information would be frustrating to learners and unrealistic relative to what would probably be done by most designers in practice. Accordingly, we decided on a "middle ground" approach in which immediate feedback was provided, but the message was downgraded in "load" (information density) to KOR (as opposed to KCR); i.e., simply indicating that the answer was "RIGHT" or "WRONG," without designating the correct answer. Typically, the time delay from the learner's first response to the item to the delayed KCR was about 30 minutes.

Procedure

The summer preparation program continued for five weeks during students' school vacation. On selected weeks students attended experimental sessions, referred to as an "ACT prep course," for one hour at a convenient time during the day or night. Prior to their participation in the experiment, they had been administered the ACT Natural Science Reading Test to determine group equivalence. During Week 1 of the research period, they were administered the Nelson-Denny Reading Comprehension Test, as an additional measure of equivalence.

During Week 2, subjects participated in the treatment phase, receiving instruction appropriate to their assigned condition. Lesson questions were administered in blocks of 10 by computer in all conditions except the no-questions (posttest-only) treatment. Supporting text, where prescribed, was available at the learning station in print booklet form. The questions-and-text and no-text treatments were conducted on alternate days to avoid subjects becoming aware of the alternative experimental condition. Students in the questions-and-text condition were allowed to use the text in any way they wished. They were not given additional instructions relative to the no-text condition except for one sentence at the beginning of each block of questions, indicating that they should read a particular section "to help answer the questions." They were then left on their own to read and reference the text whenever and for as much time as they wanted. Observation of subjects reflected use of a variety of strategies, including reading the text first and then answering the lesson questions, reading the text as questions were answered, and/or referencing parts of the text following the completion of different questions. No text material was provided during the posttest or delayed posttest.

After subjects completed the assigned treatment, they were given a 10-minute break followed by the administration of the 40-item posttest. Subjects could spend as much time as they needed to complete the instructional phase; most finished in 45 minutes to 1 hour. Two weeks later, they were readministered the posttest unannounced to assess retention. The text portions were not available during either testing.

Results

The analyses of achievement scores used a 5 x 2 x 2 mixed ANOVA on each question level. Between-subjects factors were five feedback conditions (KCR, AUC, delayed, no-feedback, no-questions) and two instructional support conditions (text vs. no-text). The within-subjects factors were five question levels (VI, II, IT, IP, and TP) and two testings (posttest and retention test). Means for all conditions are shown in Table 2.

Insert Table 2 about here

The ANOVA yielded significant main effects due to feedback, *F* (4, 90) = 13.96, *p*, < .001, MSe = 5.99; and question level, *F* (4, 360) = 135.32, *p* < .001, MSe = .92. Each of these effects was qualified by significant interactions. Two-way interactions that reached significance were feedback x question, *F* (16, 360) = 13.50, *p*, < .001, MSe = .92; support x question, *F* (4, 360) = 2.46, *p* < .05, MSe = .92; and question x testing, *F*(4, 360) = 28.60, *p* < .001, MSe = 1.19. Significant three-way interactions were feedback x question x testing, *F* (16, 360) = 4.06, *p* < .001, MSe = 1.19; and support x question x testing, *F*(4, 360) = 5.20, *p* < .001; MSe = 1.19. Further, the four-way interaction also reached significance, *F* (16, 370) = 2.29, *p* < .003, MSe = 1.19.

Interpretation of the latter interaction, which qualifies all other effects, is obviously complicated by the four factors and 100 means it encompasses. Given that every interaction involving questions x testing was significant, it seemed appropriate for simplifying the interpretation of interaction patterns to conduct, as follow-up analyses, separate feedback x support x question ANOVAs for each test (immediate and retention). Due to the large number of factors involved in these analyses, the .01 level was used in judging significance. Results from each analysis are summarized in Table 3 and reported in the sections below.

Insert Table 3 about here

Immediate Test

As shown in Table 3, the feedback ($p < .001$) and question level ($p < .001$) main effects, but not the support main effect, were significant. Significant interactions were feedback x question level ($p < .001$), and support by question level ($p < .01$).

The feedback main effect was further analyzed via Tukey follow-up comparisons of the five overall treatment means. Results indicated that all three feedback strategies, KCR (M=4.7), AUC (M = 4.7), and delayed (M=4.5), were superior ($p < .05$) to both the no-feedback (M=3.2) and no-questions (M=3.0) control strategies. Similarly, Tukey follow-up tests of the question level main effect showed means on the two identical question forms, verbatim-identical (M=4.1) and inferential-identical (M=5.2), to surpass ($p < .05$) the means on the three reworded question levels, inferential-paraphrased (M=3.5), inferential-transformed (M=3.4), and transformed-paraphrased (M=3.1).

The significant feedback x question interaction ($p < .01$) reflected a general pattern for larger differences favoring feedback means over control means to occur on identical questions (VI and II) than on reworded questions (see Figure 1). Followup analyses involved comparing the five feedback means, using a Tukey test, for each type of question. The .01 level of significance was used to reduce the overall Type I error rate. Findings indicated that on both verbatim-identical and inferential-identical questions, each of the three feedback groups (KCR, AUC, and delayed) significantly surpassed each of the control groups (no-feedback and no-questions). On inferential-paraphrased questions, the only significant difference was that AUC surpassed no-questions. No differences were found on either inferential-transformed or transformed-paraphrased questions, although on the former measure, the differences favoring the highest group, AUC, over both of the control groups, approached significance ($.01 < p$'s $< .05$).

Insert Figure 1 about here

Followup analyses of the support x question level interaction ($p < .01$) consisted of comparing the text-and-question mean to the questions-only mean on each of the five question levels (see immediate test column means on Table 2). Multiple t tests, each using a .01 significance level, were used. Findings revealed that the only significant effect occurred on verbatim-identical questions, with text-and-questions (M=5.5) surpassing questions-only (M=4.6).

Retention Test

The same main effects and interactions that were significant on the immediate test were also significant on the retention test, with the exception of the support x questions interaction (*p* > .01; see Table 2). The feedback main effect (*p* < .001) was further analyzed by Tukey tests. As occurred for the immediate test, KCR (*M*=3.9), AUC (*M*=4.0), and delayed (*M*=38) feedback each surpassed no-feedback (*M*=3.1) and no-questions (*M*=3.0). Followup analyses of the question-level main effect (*p* < .001) indicated that scores on verbatim-identical (*M*=4.2) and inferential-identical (*M*=4.3) questions were higher than those on transformed-paraphrased (*M*=2.9), inferential-transformed (*M*=3.2), and inferential-paraphrased (*M*=3.3) questions. The transformed-paraphrased mean was significantly lower than each of the other question-level means.

The significant feedback x questions interaction (*p* < .001) was further analyzed by comparing the five feedback means, using a Tukey test, for each type of question (alpha = .01). The interaction is graphically displayed in Figure 2. Findings indicated that on verbatim-identical questions, the two highest groups, delayed and KCR, surpassed the two lowest groups, no-questions and no-feedback; AUC did not differ from any other groups. On inferential-identical questions, all three feedback groups surpassed both control groups. On inferential-transformed questions, no significant differences occurred; the largest difference, that favoring AUC over no-questions, approached significance at the .01 level (*p* < .05). On inferential-paraphrased questions, the only significant difference was that AUC surpassed no-questions. On transformed-paraphrased questions, no differences occurred. The overall pattern revealed from these comparisons is similar to but not as strong as that for the immediate test, showing (a) larger differences favoring the feedback conditions over the control conditions on the two identical question types (VI and II) than on the three reworded question types (IT, IP, and TP), and (b) a tendency for AUC effects to be more positive relative to the other feedback treatments on reworded than on identical question types.

Insert Figure 2 about here

Completion Time

Lesson completion times were analyzed for subjects in the three feedback conditions using a 3(feedback) x 2(text) ANOVA. The text main effect, *F* (1,52) = 38.9, *p* < .001 was significant, confirming the expected longer completion times for subjects who received text (*M* = 57.4 min.) than for those who did not (28.9 min.). The feedback main effect approached significance, *F* (2,54) = 2.89, *p* < .06, with the ordering of means from highest to lowest being delayed (*M* = 50.5), AUC (*M* = 41.6), and KCR (*M* = 37.4).

Discussion

The results of this study supported the hypothesized benefits for learning of providing response feedback on embedded lesson questions. To most educators, this result would hardly be viewed as surprising. The effectiveness of feedback is a basic tenet of instructional theory that has been demonstrated countless times by researchers beginning with the classic verbal learning studies by Thorndike (1931) on the effects of saying "Right" or "Wrong" following a subject's response. Frequent and consistent use of feedback is also strongly promoted in today's textbooks on teaching and educational psychology (e.g., Woolfolk, 1990, pp. 543-545; Slavin, 1988, pp. 383-387). But, while the benefits of feedback in general might be taken for granted, uncertainty still exists regarding how to select and optimize uses of different forms of feedback depending on characteristics of students and the learning situation.

As suggested from the present results, one important factor influencing feedback effects is the type of questioning employed, a variable that has typically not been controlled in previous studies. Had only one level of questioning been used, our findings would have been directly dependent on the particular level selected. Given the broader perspective obtained by manipulating five questioning levels, we were able to detect several basic trends. One was for feedback benefits to decrease as the similarity of posttest questions to corresponding lesson questions decreased. In other words, larger feedback effects occurred on the "identical" items than on the reworded ones. Another, in support of Hypothesis 2, was for the relative benefits of AUC feedback to increase as posttest question similarity decreased. Third, feedback effects relative to the control conditions tended to be greater without text than with text.

Better understanding of these outcomes can be obtained by analyzing the nature of the instructional support provided by the different feedback conditions. As suggested here and in previous studies involving identical lesson and posttest questions (Kulhavy 1977; Kulhavy & Anderson 1972; Smith 1988), the most direct benefit of KCR-type feedback (whether immediate or delayed) is informing learners of the correct answers to lesson questions. Thus, even when the level of learning does not extend beyond rote memorization, the benefit should be an increased ability to reconstruct those associations and identify the answers when the same questions appear again on a lesson posttest. Looking again at Figure 1, that effect is reflected by the three feedback groups' greater superiority over two control groups in the two conditions where posttest questions were exact replications of lesson questions (verbatim-identical and inferential-identical).

It has further been proposed that for strengthening associations between questions and correct answers, delayed feedback is especially advantageous by providing a second exposure to the item presentation at the end of the lesson (Kulik & Kulik, 1988) and by reducing proactive interference (Kulhavy & Anderson, 1972). Consistent with the emphasis of these explanations on rote-learning processes (i.e., connecting specific answers to associated questions), delayed-feedback effects have primarily been found in situations involving identical lesson and criterion test items (e.g., Kulik & Kulik, 1988; Sturgis, 1978; Suber & Anderson, 1975). Similarly, on both the immediate and retention tests in the present study, delayed-feedback was directionally higher than all other feedback conditions on verbatim-identical questions, and was significantly higher than the control conditions on verbatim-identical and inferential-identical questions only. Looking at Figures 1 and 2, the effectiveness of delayed feedback relative to the other conditions tended to decline as a general pattern as lesson-posttest question similarity decreased.

Despite its informational properties, feedback by itself does not necessarily increase depth-of-processing of the material being learned. In fact, a possible disadvantage of feedback may be that of supplanting the natural tendency of questions to stimulate information processing or "mathemagenic activity" (Rothkopf, 1966), as the learner searches memory or the text to find the answers to questions. That is, once the correct answer is identified, the learner may resort to memorizing or merely acknowledging it without engaging in further processing. In a similar vein, Andre (1979) discussed how the availability of feedback in text can short circuit the instructional effects of adjunct questions by allowing subjects to peek ahead at the answers and thus avoid searching the text to find them on their own. Relevant to these interpretations, feedback effects were noticeably smaller for the reworded question forms than for the identical forms. It thus appears that feedback, especially KCR and delayed, generally did not stimulate deeper processing of the present material, while promoting only a limited degree of transfer to questions testing the same information as the lesson questions but differing in phrasing or structure.

From an information processing perspective, AUC feedback would appear to offer potential advantages over KCR as a result of requiring continued involvement with a question following an incorrect response (Dempsey & Driscoll, 1989; Noonan 1984). Such activity can increase depth-of-processing for the item (Smith, 1988), provided that the learner is not just guessing randomly (Underwood, 1963). On the present task, AUC tended to be effective relative to both KCR and delayed feedback on reworded questions, but was relatively ineffective on identical questions (see Table 2). This pattern suggests that AUC may have served to promote higher-order learning of the material, as learners reconsidered the questions they missed in light of their previous error responses and the remaining alternatives. Further research is needed to explore this possible function of AUC as well as to reconcile the mixed findings regarding AUC effects reported in previous studies (cf, Angell, 1949; Clariana, 1990; Dempsey & Driscoll, 1989; More, 1969).

That feedback effects tended to be stronger in the no-text than in the text condition seems predictable, given that the former subjects were completely dependent on the adjunct questions to learn the information. This result should not be interpreted to imply that learning is as good or better from questions only without accompanying text. Although there is little doubt that tests can teach (e.g., Fisher, Williams, & Roth, 1981; Meyer, 1965; Pressey, 1926, 1950), what is learned will be restricted by the particular focus of the items that happen to be included. The implication of this idea, along with our earlier discussion of feedback effects, is that feedback studies that employ identical lesson and posttest questions narrow the content domain to those specific questions, and, in the process, maximize the importance of the questions (and accompanying feedback) while minimizing the value of contextual support (e.g., text).

Another aspect of the present text versus no-text comparison was the failure to support the predicted tendency (Hypothesis 3) for text to become more facilitative as question level increased. In fact, the significant support x question interaction obtained on both tests reflected the opposite pattern; for example, the largest difference favoring text over no-text occurred on the lowest level question type, verbatim-identical. The suggestion is that subjects' processing of the text might have been at a fairly low level. An important factor in this regard appears to be the difficulty of the material and high reading level of the passages.

In summary, the major findings evidenced in the present research were that: (a) feedback was generally effective for learning, but more so on the lower-level (identical) questions than on the higher-level (reworded) ones; (b) feedback information had greater impact in the absence of supporting text than with supporting text; (c) relative to other treatments, AUC feedback tended to increase in effectiveness and delayed feedback to decrease in effectiveness as question level was varied from identical types to reworded types.

Past feedback studies, including the present investigation, have focused primarily on comparing learner achievement under different feedback strategies. Follow-up research that gives greater focus to intervening learning behaviors (e.g., degree of task engagement, referencing of text, note-taking) would shed light on the question of how information processing and study activity are influenced by those strategies. The present completion time results, for example, are suggestive of varied degrees of task engagement that occurred in the three feedback conditions. Acquiring better understanding of such processes should help to identify ways of using feedback more effectively to increase the range and degree of learning from embedded lesson questions.

References

Anderson, R.C. (1972). How to construct achievement tests to assess comprehension. Review of Educational Research, 42(2), 145-170.

Andre, T. (1979). Does answering higher-level questions while reading facilitate productive learning? Review of Educational Research, 49(2), 280-318.

Angell, G.W. (1949). The effect of immediate knowledge of quiz results on final examination scores in freshman chemistry. Journal of Educational Research, 42(5), 391-394.

Bormuth, J.R., Manning, J., Carr, J., & Pearson, D. (1970). Children's comprehension of between- and within-sentence syntactic structure. Journal of Educational Research, 42(5), 391-394.

Clariana, R.B. (1990). A comparison of AUC feedback and KCR feedback under two conditions of contextualization. Journal of Computer-Based Instruction, 17(4), 125-129.

Dale, E., & Chall, J. (1948, January). A formula for predicting readability. Educational Research Bulletin, 27, pp. 11-20, 37-54.

Dempsey, J.V. (1988). The effects of four methods of immediate corrective feedback on retention, discrimination error, and feedback study time in computer-based instruction. Dissertation Abstracts International, 49(6), 1434.

Dempsey, J.V., & Driscoll, M.P. (1989). The effects of four methods of immediate corrective feedback on retention, discrimination error, and feedback study time in computer-based instruction. A paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Dick, W., & Latta, R. (1970). Comparative effects of ability and presentation mode in computer-assisted instruction and programmed instruction. Audio-Visual Communication Review, 18(3), 34-45.

Fisher, K., Williams, S., & Roth, J. (1981). Qualitative and quantitative differences in learning associated with multiple-choice testing. Journal of Research in Science Teaching, 18(5), 449-464.

Flesch, R.F. (1948). A new readability yardstick. Journal of Applied Psychology, 32, 221-233.

Gilman, D.A. (1969). Comparison of several feedback methods for correcting errors by computer-assisted instruction. Journal of Educational Psychology, 60(6), 503-508.

Guthrie, E.R. (1935). The psychology of learning (1st ed.) New York: Harper & Brothers.

Hannafin, M.J., & Reiber, L.P. (1989). Psychological foundations of instructional design for emerging computer-based instructional technologies: Part I. Educational Technology Research and Development, 37(2), 91-101.

Kulhavy, R.W. (1977). Feedback in Written Instruction. Review of Educational Research, 47,(1), 211-232.

Kulhavy, R.W., & Anderson, R.C. (1972). Delay-retention effect with multiple-choice tests. Journal of Educational Psychology, 63(5), 505-512.

Kulhavy, R.W., & Stock, W.A. (1989). Feedback in written instruction: The place of response certitude. Educational Psychology Review, 1, 279-308.

Kulik, J.A., & Kulik, C. (1988). Timing of feedback and verbal learning. *Review of Educational Research*, *58*(1), 79-97.

Merrill, J. (1985). *Levels of questioning and forms of feedback: Instructional factors in courseware design*. Paper presented at the Annual Meeting of the American Educational Research Association, Chicago 1985. (ERIC Document Reproduction Service No. ED 266 766)

Merrill, J. (1987). Levels of questioning and forms of feedback: Instructional factors in courseware design. *Journal of Computer-Based Instruction*, *14*, 18-22.

Meyer, D.E. (1965). *Adjunct to self-study for aircrew refresher training under operational conditions in the Air Defense Command*. Aerospace Medical Research Labs, Wright-Patterson AFB, OH. (ERIC Document Reproduction Service No. ED 131 830)

More, A.J. (1969). Delay of feedback and the acquisition and retention of verbal materials in the classroom. *Journal of Educational Psychology*, *60*(5), 339-342.

Newman, M. I., Williams, R.G., & Hiller, J.H. (1974). Delay of information feedback in an applied setting: Effects on initially learned and unlearned items. *Journal of Experimental Education*, *42*(4), 55-59.

Noonan, J.V. (1984). Feedback procedures in computer-assisted instruction: Knowledge-of-results, knowledge-of-correct-response, process explanations, and second attempts after explanations. *Dissertation Abstracts International*, *45*(1), 131.

Peeck, J., & Tillema, H.H. (1978). Delay of feedback and retention of correct and incorrect responses. *Journal of Experimental Education*, *38*, 139-145.

Pressey, S.L. (1926). A simple apparatus which gives tests and scores - and teaches. *School and Society*, *23*, 373-376.

Pressey, S.L. (1950). Development and appraisal of devices providing immediate automatic scoring of objective tests and concomitant self-instruction. *The Journal of Psychology*, *29*, 417-447.

Rothkopf, E.Z. (1966). Learning from written instructive materials: An exploration of the control of inspection behavior by test-like events. *American Educational Research Journal*, *3*(4), 241-249.

Schimmel, B.J. (1983). *A meta-analysis of feedback to learners in computerized and programmed instruction*. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada. (ERIC Document Reproduction No. ED 233 708)

Schimmel, B.J. (1986). Feedback use by low-ability students in computer-based education. *Dissertation Abstracts International*, *47*,(11), 4068.

Slavin, R.E. (1988). *Educational psychology*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Smith, P.L. (1988). *Toward a taxonomy of feedback: Content and scheduling*. A paper presented at the Annual Meeting of the Association for Educational Communications and Technology, New Orleans, LA.

Spock, P.A. (1987). Feedback and confidence of response for a rule-learning task using computer-assisted instruction. *Dissertation Abstracts International*, *48*,(5), 1109.

Sturges, P.T. (1978). Delay of informative feedback in computer-assisted testing. *Journal of Educational Psychology*, *70*(3), 378-387.

Suber, J.R., & Anderson, R.C. (1975). Delay-retention effect in natural classroom settings. *Journal of Educational Psychology*, *67*(2), 170-173.

Tait, K., Hartley, J.R., & Anderson, R.C. (1973). Feedback procedures in computer-assisted arithmetic instruction. British Journal of Educational Psychology, 43, 161-171.

Thorndike, E.L. (1931). Human learning. New York: Appleton-Century, Crofts.

Travers, R.M. W., Van Wagenen, R.K., Haygood, D.H., & McCormick, M. (1964). Learning as a consequence of the learner's task involvement under different conditions of feedback. Journal of Educational Psychology, 65(3), 167-173.

Underwood, B.J. (1963). Stimulus selection in verbal learning. In C.J. Cofer and B.S. Musgrave (Eds.), Verbal behavior and verbal learning: problems and processes. New York: McGraw-Hill.

Waldrop, P.B., Justin, J.E., & Adams, T.M. (1986). A comparison of three types of feedback in a computer-assisted instruction task. Educational Technology, 26, 43-45.

Woolfolk, A. (1990). Educational psychology for teachers. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Table 1

Text Portion and Corresponding Questioning Levels

Text portion

In conductors, the electrons move easily; in insulators, they do not. Since moving electrons carry energy as well as charge, a good electrical conductor normally is also a good heat conductor, and an electrical insulator is also a poor heat conductor.

Questioning Levels

Verbatim Identical [a]

Normally, a good electrical conductor is also:

a. a good heat conductor.
b. a poor heat conductor.
c. a good electrical insulator.
d. the best electrical insulator.

Inferential Identical [b]

Copper is a poorer heat conductor than silver, then copper probably:

a. has a smaller heat capacity than silver.
b. is a poorer electrical conductor than silver.
c. is a semiconductor.
d. is a better electrical conductor than silver.

Inferential Transformed [c]

Copper is a poorer electrical conductor than silver, then copper probably:

a. is a semiconductor.
b. has a smaller heat capacity than silver.
c. is a poorer heat conductor than silver.
d. is a better heat conductor than silver.

Inferential Paraphrased [a]

Copper does not move heat energy as well as silver, so copper probably:

a. is a semiconductor.
b. moves electrical energy better than silver.
c. can hold less heat energy than silver.
d. does not move electrical energy as well as silver.

Inferential Transformed & Paraphrased [a]

Copper does not move electrical energy as well as silver, so copper probably:

a. moves heat energy better than silver.
b. is a semiconductor.
c. does not move heat energy as well as silver.
d. can hold less heat energy than silver.

Note: The letter of the correct answer is underscored in each item.
[a] Fabricated question used for illustrative purposes
[b] Actual lesson question for the text passage shown
[c] Actual posttest question for the text passage and lesson question shown

Table 2

Treatment Posttest and Retention Test Means of the Five Question Levels

Question Levels and Support

Feedback and Testing	Verbatim Identical		Inferential Identical		Inferential Transformed		Inferential Paraphrased		Transformed Paraphrased		Row Means Overall
	Q[a]	QT[b]	Q	QT	Q	QT	Q	QT	Q	QT	
Immediate Test											
KCR	5.9	6.1	6.5	7.1	4.6	3.2	2.7	4.1	3.4	3.6	4.7
AUC	5.5	5.4	6.7	5.5	4.4	3.6	4.8	3.7	4.0	3.2	4.7
Delayed	6.4	6.4	6.1	6.7	3.5	3.6	3.4	3.5	2.3	2.9	4.5
No-feedback	2.8	4.8	3.3	2.8	2.9	2.5	3.1	3.4	3.4	3.3	3.2
No-question	2.4	4.9	3.6	3.4	2.5	2.7	2.6	3.2	2.4	2.5	3.0
Column means	4.6	5.5	5.2	5.1	3.6	3.1	3.3	3.6	3.1	3.1	4.0
Retention Test											
KCR	4.4	4.8	5.0	5.4	3.2	3.4	3.3	3.7	2.4	3.0	3.9
AUC	4.4	4.4	5.6	4.5	4.0	3.2	4.1	3.5	3.1	3.2	4.0
Delayed	5.2	5.0	4.9	5.2	3.4	3.3	3.3	2.8	2.7	2.3	3.8
No-feedback	2.8	4.1	3.1	3.2	2.9	2.8	2.9	3.0	3.2	3.2	3.1
No-question	2.6	4.4	2.9	3.2	2.4	2.9	2.7	2.8	2.8	2.9	3.0
Column Means	3.9	4.5	4.3	4.3	3.2	3.1	3.3	3.2	2.8	2.9	3.6

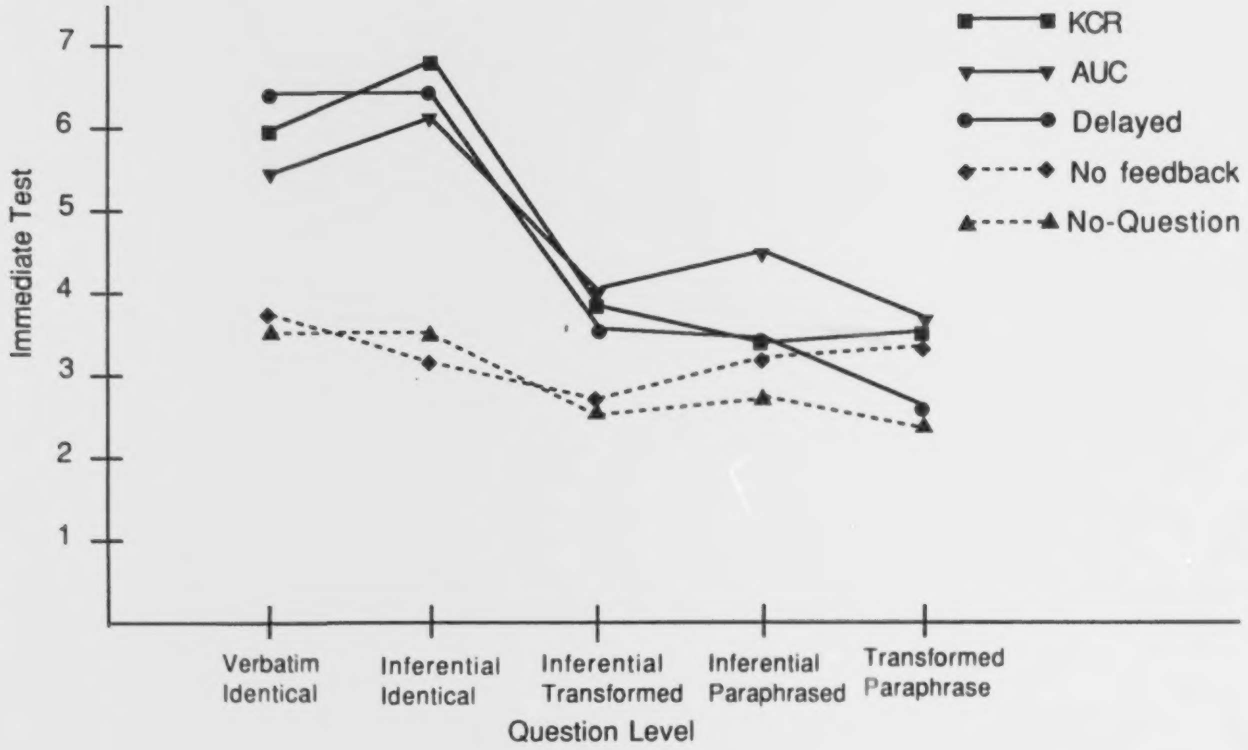
Note. Scores could range from 0-8 in each cell.
[a]Q = Questions only; [b]QT = Text and Questions

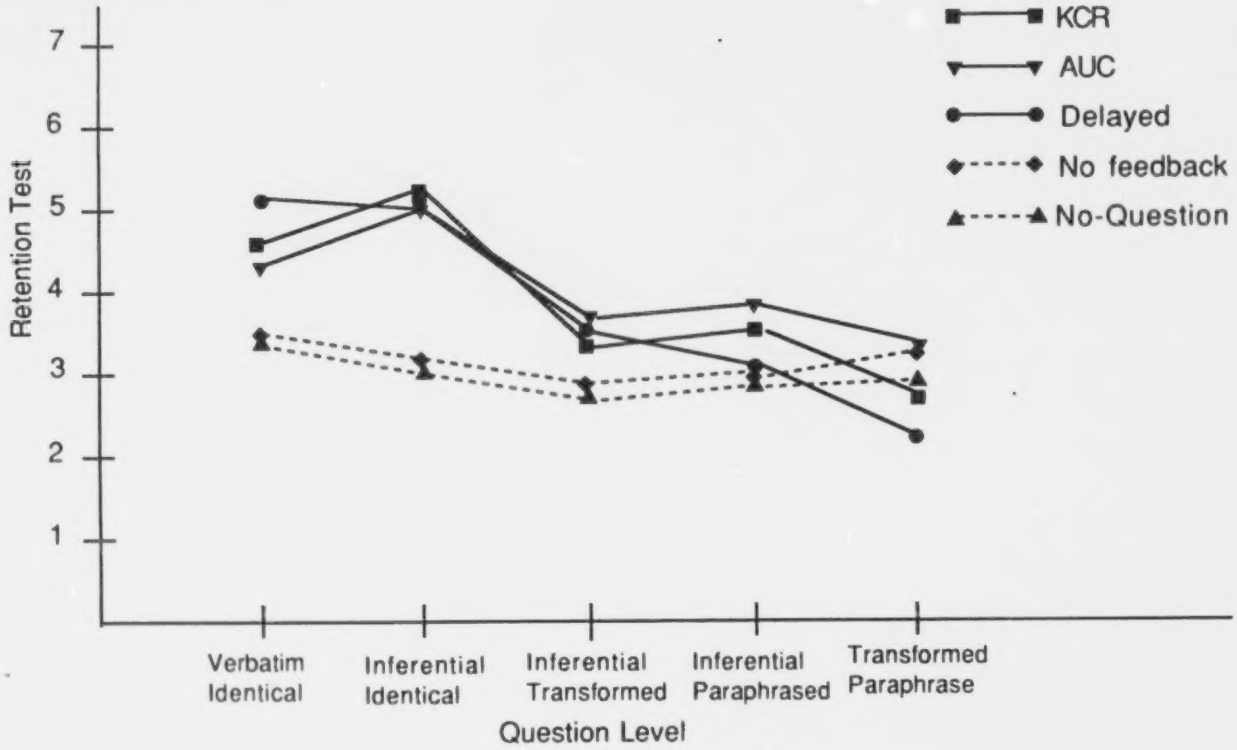
Table 3

Results of Feedback x Support x Question Level ANOVAs by Testing

		Testing			
		Immediate		Retention	
Source of Variance	df	MS	F	MS	F
Between Subjects					
Feedback (F)	4	68.03	16.05**	22.18	9.13**
Support (5)	1	1.92	.45	1.80	.74
F x S	4	7.57	1.78	4.79	1.97
Error	90	4.24		2.43	
Within Subjects					
Question Level (Q)	4	101.27	68.78**	43.08	65.27**
F x Q	16	10.97	7.45**	5.00	7.58**
S x Q	4	6.43	4.37*	2.18	3.31
F x S x Q	16	2.65	1.80	.90	1.36
Error	360	1.47		.66	

* $p < .01$
** $p < .001$


Immediate Test
7
6
5
4
3
2
1
Verbatim Identical
Inferential Identical
Inferential Transformed
Inferential Paraphrased
Transformed Paraphrase
Question Level
KCR
AUC
Delayed
No feedback
No-Question


KCR
AUC
Delayed
No feedback
No-Question
Retention Test
7
6
5
4
3
2
1
Verbatim Identical
Inferential Identical
Inferential Transformed
Inferential Paraphrased
Transformed Paraphrase
Question Level

Title:

Identifying a Range of Performance Improvement Solutions
- High Yield Training to Systems Redesign -
Through Evaluation Research

Authors:

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Identifying A Range of Performance Improvement Solutions - High Yield Training to Systems Redesign - Through Evaluation Research

Introduction

The effectiveness of any organization is dependent on its most important resources: people. Systems and techniques abound for the purpose of developing human resources. These are designed to help an organization get the best performance from some type of training. Analysis can show what kind of training is most appropriate for achieving improved performance and also reveal when training is not necessary in order to achieve improved performance. One method that accomplishes both of these ends is evaluation research (Geroy and Wright, 1988).

Figure 1
Evaluation Research Model

1. Selection of Evaluation Research Purpose

__ Needs Assessment
__ Basic Research
__ Coverage Accountability
__ Small Scale Testing
__ Evaluation
__ Input Assessment
__ Policy Analysis
__ Fiscal Accountability
__ Economic Analysis

2. Identify the Technique to be Used

__ Front End Analysis
__ Formative Evaluation
__ Program Monitoring
__ Evaluability Assessment
__ Impact Evaluation
__ Evaluation of Evaluation

3. Develop Research Questions

4. Establish a Collaborative Utilization Focused Process

A. Compose Task Force
- All stakeholders represented
- Power exists to act on findings
- Time committed
- Process and results valued

B. Structure Task Force Activities
- Focus clarification
- Methods and measurement selection
- Review of instruemtns and strategies
- Data interpretation meeting

5. Determine Research Focus

__ Evaluation research with goals
__ Evaluation research without goals

6. Determine Evaluation Research Strategy

__ Scientific - hypothetical - deductive
__ Anthropological - holistic - inductive

7. Select Data Collection Method

__ Formal instruments, e.g., survey
__ Non-formal instruments, e.g., structured or non-structured interview

8. Implement Research

9. Analyze and Report Results

Geroy and Wright, 1988

Evaluation research is a pragmatic, program focused research strategy of analysis for decision makers. Its purpose is to provide data that can enable decision making, through analysis of pros and cons, through prioritizing, or through the application of decision making criteria, etc. What gives evaluation research its strength is the extent to which the stakeholders are involved throughout the research process. This involvement yields four primary benefits: feasibility in terms of cost, timeliness and manner of implementation; and utility, accuracy, and proprietorship in terms of outcome.

Beginning with Phase One: Selection of Evaluation Research Purpose (See Figure 1), the research evaluators and the stakeholders "become collaborating partners in the search for useful information" (Geroy and Wright, 1988, p. 23). From then on, collaboration is structured at each step of the process. This collaboration provides a means of monitoring the appropriateness and relevancy of each activity and strategy, as well as its feasibility regarding time and resources. As a result, the information gathered is more likely to be on target in addressing the needs of the stakeholders. It is also more likely to facilitate decision making both through its accuracy and the usefulness of the way the information is reported.

Furthermore, those who have helped structure the process, as well as those from whom the data is derived, have greater ownership of the results. Their potential buy-in to the recommendations stemming from the research is increased (proprietorship). In each case the data gathered are used to either create, maintain or improve program policy and / or implementation practices.

This article describes a needs assessment process that identifies a range of performance improvement strategies using the steps of the Evaluation Research Model.

Overview

The Professional Development Committee of a mid-sized community college in suburban Philadelphia had the responsibility of identifying professional development activities for the administrators, faculty and support personnel of the college. In light of concern voiced over past professional development offerings, the committee decided to use outside consultants to help them plan their professional development program. After three lengthy meetings with the committee, the consultants identified five problems imbedded in the environment that were influencing the decision making process:

- lack of agreement among committee members as to how to select professional development opportunities,
- limited communication of information across functional groups,
- negative perceptions of previous professional development efforts,
- perceived unresponsiveness of decision makers to past suggestions related to professional development, and
- recent loss of incentive due to reduced power and autonomy within the faculty structure.

It became apparent that the final professional development plan for the 1991-92 academic year had to:

- involve and empower all employees (stakeholders) equally in identifying professional development needs,
- develop a means by which the planning committee itself would recognize that certain non-training actions were required in order to maximize the worth of training,
- elicit data that would represent needs of the employees of the college,
- elicit valid data while facilitating a process with 280 participants, and
- provide decision makers with systematic process for selecting professional development activities that will yield maximum results for cost and effort.

Using the evaluation research strategy (Geroy & Wright, 1988) as a guideline, a needs assessment was conducted with 280 support-staff, faculty and administrators. The Nominal Group Technique (Debeque & Van Deben, 1974), a comprehensive process for data gathering within a group setting, was taught to representatives from each of these three groups. These representatives facilitated the participation of virtually all employees at the college in identifying a prioritized list of items that would enable these persons to "do their job better" - from their perspective. Analysis of the suggested performance improvement needs utilized the Performance Technology Model (Gilbert, 1978) and revealed that the solutions fell into five categories of intervention: high yield training, direction and flow of information, resources, performance incentives, and medium yield training. Results indicated that improving employee performance required altering information, resource and incentive systems and that without these alterations, most training was likely to have minimal effect.

Methodology

Each stage of the Evaluation Research Model was incorporated into some phase of the project. In clarifying the goals of the professional development planning process, the Professional Development Committee and the consultants used group discussion and the Nominal Group Technique as they:

- Selected and Evaluated the Research Purpose: Needs Assessment - Stage One,
- Identified the Technique to Be Used: Front End Analysis - Stage Two, and
- Developed the Research Question: "What do I need to do my job better?" - Stage Three.

Focus groups were then held with representatives from each functional area in order to identify any perceptions or problems in the workplace that might have an impact on the planning process. At this point, the Committee and the consultants:

- Established a Collaborative Utilization Focused Process - Stage Four, and
- Determined Research Focus: Evaluation Research Without Goals - Stage Five.

With the data gathered through committee meetings and the focus groups, the consultants then:

- Determined the Evaluation Research Strategy: Anthropological-Holistic-Inductive - Stage Six
- Selected the Data Collection Method: Non-formal Instrument, Nominal Group Technique - Stage Seven

Assessment Technique

The Nominal Group Technique was used to gather data for the needs assessment (Debeque and Van Deben, 1974). This technique utilizes a structured group meeting conducted by a group leader or facilitator in five steps.

STEP ONE:

- Group members sit around a table, but initially, no talking takes place. Each individual has a sheet of paper with the "nominal question" on it. This question provides the primary focus of the meeting. This question is carefully constructed prior to the meeting in order to generate the required information. Participants, independently and silently, write down as many answers to the question as possible.

STEP TWO:

- After approximately ten minutes, the facilitator , going round-robin, calls on each member of the group to give one of his or her ideas. Each idea is listed on a flip chart and numbered sequentially. The purpose of this stage is to make sure that each participant is given equal opportunity to share his or her ideas, so that highly verbal individuals are not dominant. Thus all discussion and judgement are postponed.

STEP THREE:

- The facilitator reviews each idea sequentially, encouraging clarification questions, elaborations, support for an idea, as well as rebuttals, or hitch-hiking to new ideas. This phase is complete when all ideas have been reviewed.

STEP FOUR:

- This stage is optional depending on the number and kind of responses generated in Step Two. When there is great overlap of ideas, the group can categorize ideas by topic. This can facilitate the ranking that follows in Step Five. It is necessary, however, for members of the group agree on the categories established and the items that go into them.

STEP FIVE:

- Each participant silently and privately ranks the ideas by assigning a numerical value to the idea. Depending on the purpose of the NGT the ranking criteria could be cost of implementation, feasibility, importance, etc. The highest number in the ranking being the total number of the ideas (or categories). Each member's ranking of each idea is recorded and the average rank of each item is derived. This yields the group's priorities in relation to the ideas.

The advantages of the NGT are numerous, especially when one of the goals of the activity is to involve stakeholders. The NGT assures that each person has an equal opportunity to express his or her ideas and protects against dominant personalities. It stimulates the generation of ideas through silent writing in Step One and the round-robin listing in Step Two, thus preventing closure on ideas before all are equally considered. All participants have an opportunity to reflect on all ideas and have their questions and concerns addressed. Silent ranking gives equal weight to each opinion during decision making and reduces peer pressure to support one idea. Furthermore, the NGT is cost and time effective. (Scott and Deadrick, 1982)

Implementation, Stage Eight of the Evaluation Research Model, took place in several steps. Representatives from each functional group were identified as facilitators of the NGT. These volunteers were trained for one-half day in how to facilitate the NGT. Finally, all employees of the college were gathered for a day and a half during which three rounds of the NGT were conducted.

On the morning that all employees meet together, the Needs Assessment Process was introduced and ice breaker activities, focusing on the mission of the college, were conducted. These activities were designed to encourage the free flow of ideas during the afternoon NGT sessions.

After lunch, each functional group, administrators, support staff and faculty, met in a different location. There they divided into groups of ten where the trained volunteers facilitated NGT Round One: Identify Needs and Round Two: Prioritize Needs. The question upon which the NGT was focused was "What do I need to do my job better?" All data from both Rounds were collected and volunteers from the support staff, some members of the Professional Development Committee members and the consultants worked until 10:00 pm organizing, typing and copying ALL responses.

The next morning each of the 280 participants received a copy of the responses of his or her functional group, as well as the responses of the other two groups. This served several purposes. It facilitated Round Three: Generate Solutions, by increasing the likelihood of constructive solutions. For instance, a review of all of the responses might reveal that some of the needs that might have appeared valid at first glance, were less so when compared to needs from other groups. The quick turn around also demonstrated responsiveness on the part of the committee to employee suggestions.

By the end of the day and a half, the project had evolved through the first eight stages of the Evaluation Research Model and utilized the Nominal Group Technique in three separate contexts: establishing the goals of the project (15 participants), training the facilitators (40 participants), and conducting the needs assessment (280 participants).

Stage Nine: Analyzing and Reporting Results was carried out over the six weeks that followed. During this time, The Professional Development Committee categorized all of the needs and solutions using the Performance Technology Model. The resulting categories facilitated the decision making analysis.

Analysis Model

The premise of performance technology is that there are a variety of factors in the workplace that have bearing on performance effectiveness and that appropriately adjusting these factors can yield exemplary performance, often without training. Thus, it behooves those responsible for the performance of others to identify environmental and individual factors in a given workplace that will not only improve performance, but also maintain exemplar quality without costly training.

These factors are perhaps best represented by the Behavior Engineering/PROBE Model developed by Thomas Gilbert (1978, 1982) which is the basis of the Performance Technology Model (See Figure 2.). This model identifies the kinds of things that can be done to improve and maintain performance, one of the primary goals of any professional development project.

It is Gilbert's claim that any job that is supported in all six of the areas of the Model should "carry a guarantee of high competence, provided that management was structured so as to really deliver these things and had a clear focus on the mission of the job in the first place" (1978, p. 87).

Research and experience verify that without good needs assessment, training is likely to be the performance improvement intervention of choice. When training is used, but it's not the most effective solution; wants instead of needs are usually being addressed. At the same time, the value of training yields less than optimal return on the dollar and time investment, and has little long term impact on the organization as a whole (Kaufman, 1986).

Strategies related to evaluation research and performance technology have proven effective in both carrying out "front end" identification of needs (Geroy & Wright, 1988; Gray

1987; Debeque & Van Deben, 1974) and deciding how to address the needs so that the training that is eventually done will have high yield to the trainee and the organization (Earle, 1990). Performance technology helps to indicate where training is not the best choice of intervention and if training is the best intervention, what kind of training is best suited to meet the need.

Figure 2
Behavior Engineering Model

INFORMATION 1. Relevant and frequent feedback about the adequacy of performance. 2. Descriptions of what is expected of performance. 3. Clear and relevant guides to adequate performance.	INSTRUMENTS 1. Tools, resources and materials designed to achieve performance needs.	INCENTIVES 1. Adequate financial incentives made contingen upon performance. 2. Nonmonetary incentives available. 3. Career development opportunities.
KNOWLEDGE 1. Systematically designed training that matches requirements of exemplary performers.	CAPACITY 1. Selection of qualified personnel.	MOTIVES 1. Assessment of people's willingness to work for available incentives.

(Gilbert, 1978)

Results

The solutions generated from Round Three of the Nominal Group Technique were tabulated by the volunteers over a six week period. Lists of prioritized needs and suggestions were then organized by kind in order to facilitate analysis. For instance, all suggestions that had to do with the need for clarification or revision of the budget were grouped together. This is also a category of solutions. The process of grouping was conducted separately for faculty, support staff and administrators.

At the conclusion of this process, three separate lists of needs/solutions were forwarded to the consultants. Review of the data indicated that the groups of ideas/needs could be combined into at least one of five categories, depending on the type of solutions that would meet the need.

Category One: High Yield Development Programs

- The needs in this category could be met by effectively designed training that matched the skill and knowledge requirements of a specific job function. The term high-yield indicated that the benefit from the program was greater than the cost of implementing the program.

Category Two: Information

- Three general solutions met the needs in this category. The first solution was to provide descriptions of what was expected of performance. Second, to develop clear and relevant guides for job performance. Third, to provide relevant and frequent feedback about the level of performance relative to the expectations.

Figure 3
Findings: Administration

NEED THEMES	SOLUTION CATEGORIES					
	High-Yield Development Programs	Information	Resources	Incentives	Moderate Yield Development Programs	TOTAL NEEDS
1. Training: sensitivity, interpersonal relations, trust	12				10	22
2. Clarification of goals, objectives, policy procedures, practices		16				16
3. Communication		15				15
4. More help - additional personnel			11			11
5. Equipment needs			6			6
6. Recognition - appreciation				6		6
7. Budget	3	3				6
8. Space requirements			3			3
9. Delegation / attainment	1	1				2
TOTAL BY SOLUTION	16	35	20	6	10	87

The counts in the cells represent the number of times a need was indicated.

Category Three: Resources

- This category involved needs that could be solved by more equipment, better tools, a more effective working environment, or other solutions that require additional funding.

Category Four: Incentives

- Needs that could be met by adequate financial and non-financial incentives fall into this category. Optimally, these incentives should be based on performance. Also, career-development opportunity solutions addressed these needs.

Category Five: Moderate-Yield Development Programs

- This category was similar to Category One except for the yield derived from the implementation of the program. The cost of the program would not have been balanced by the benefit. This was probably due to another related need that fell into the Second, Third or Fourth Categories. It was recommended that programs in this category not be implemented until the other related needs were met. Once the related needs were met, however, the yield of the program might change, or the need for the program might be eliminated entirely.

These categories represent four of the cells of the Behavior Engineering Model.

Figure 4
Findings: Support

NEED THEMES	SOLUTION CATEGORIES					
	High-Yield Development Programs	Information	Resources	Incentives	Moderate Yield Development Programs	TOTAL NEEDS
1. Equipment needs, Environment space needs		3	30			33
2. Communication: Cooperation between departments	4	21			3	28
3. Uniformity of policies and practices		17				17
4. Recognition/respect: appreciation reward employee identification		8		4	1	13
TOTAL BY SOLUTION	4	49	30	4	4	91

The counts in the cells represent the number of times a need was indicated.

In comparing the categories across groups, it is interesting that, in each case, information needs/solutions were offered more than any other, and that resource needs/solutions were second. This is consistent with the experience of many performance technologists who often find, during the course of needs assessments, that information, in the form of clearly defined performance expectations, policies, procedures and feedback, is the greatest opportunity for improvement related to performance improvement. (Gilbert, 1991)

Providing information is less time consuming and less costly than providing training. It is also more likely to result in performance improvement. Training often occurs when an information problem still exists. Employees will still not be clear on performance expectations and do not receive feedback that will help them assess their progress towards performance expectations. In these situations, they simply cannot make maximum performance improvement. This results in frustrated employees and a frustrated organization.

As a result of the project findings and recommendations, the Professional Development Committee undertook the following follow-up activities.

- Conduct re-orientation program for all employees (INFORMATION)
- Use re-orientation program as the new employee orientation program (INFORMATION)
- Implement training identified as high yield: (TRAINING)
    - Interpersonal Problem Solving for administrators
    - Communication Skills for faculty and support staff
    - PC Teaching Methods for faculty
    - Delegation Skills for administration
    - Budget Planning for administration

Figure 5
Findings: Faculty

NEED THEMES	SOLUTION CATEGORIES					
	High-Yield Development Programs	Information	Resources	Incentives	Moderate Yield Development Programs	TOTAL NEEDS
1. Money/resources budget			64	12		76
2. Discipline identification as with former Dept structure - specific staff development activities and programs	8	25		24		57
3. communication						40
a. interdepartmental contacts/ cooperation		18				
b. clarifying update purpose		1				
c. open forum issues to stimulate communication		5				
d. stremline current College bureaucratic procedures		6				
e. budgeting process		9				
4. Equipment needs	3	3	22		3	31
5. Self-determination issues-input in decision making		24				24
6. Professional vs. employee identity - administrative /faculty dialog & relations		19				19
7. Training: PC's, teaching	12	2			5	19
8. How to deal with special	3	4	3		2	12
9. Recognition				4		4
10. Team building		2			2	4
TOTAL BY SOULTION	26	118	89	40	13	286

The counts in the cells represent the number of times a need was indicated.

- Establish a new committee to oversee non-instructional performance improvement solutions
- Present an overview of performance technology to the Professional Development Committee
- Review results of training and non-instructional interventions after one year

The solutions reported in the resources, incentives and information categories were not immediately addressed by the committee for two reasons. Their mission had been to plan professional development activities within the traditional paradigm of professional development. Once their vision of professional development had been expanded to include non-training factors that support performance improvement, they felt that the most responsible strategy would be to have a new committee established that could focus exclusively on non-instructional performance improvement solutions. Secondly, the original committee was not empowered to authorize the budget expenditures that might be necessary to implement resource and incentive solutions.

Conclusions

The benefits from this project are numerous. Evaluation research (Geroy & Wright, 1988) facilitated the decision making regarding the relative worth of and priority of actions to promote both professional growth and institutional development. Without the project, the Professional Development Committee would have selected training activities that might, or might not, have addressed some of the needs of the college employees. Certainly, they would not have considered non-instructional needs.

All of the challenges that were identified by the consultants at the beginning of the project were addressed:

- All employees (stakeholders) were involved equally in identifying professional development needs. This was particularly significant for the support staff, whose work keeps an organization moving. It was the first time they felt anyone had listened to their concerns or ideas.
- The planning committee did recognize that certain non-training actions were required in order to maximize the worth of training
- Data was elicited from all 280 employees that represented both wants and needs of the employees of the college. The degree of overlap of needs/solutions validated both the data and the effectiveness of the process.
- Decision makers were provided with with systematic process for selecting professional development activities that will yield maximum results for cost and effort.

There were also benefits related to the practice of performance technology. This project illustrated the number and kind of responses generated through the nominal group technique, as well as the range of professional development options that emerge from NGT responses. It reflected the cutting edge of performance technology by virtue of: applying of performance technology in an academic setting, involving all employees of the organization, addressing the desire of the organization for training while simultaneously, presenting alternative performance improvement solutions, and introducing performance technology as the decision making model for all HRD functions of the organization. The project also provided techniques, references and examples that can be used in convincing decision makers of the value of conducting a needs assessment.

REFERENCES

Anderson, S.B. & Ball, S. (1978). *The profession and practice of program evaluation.* San Francisco: Jossey-Bass.

Debeque, A.L. & Van Deben, A.H. (1971). A group process model for problem identification and problem planning. *Journal of Applied Behavioral Science*, 7: 466-492.

Gepson, J., Martinko, M.J. & Belina, J. (1981). Nominal group techniques. *Training and Development Journal*, September, pp. 78-83.

Geroy, G.D. & Wright, P.C. (1988). Evaluation research: a pragmatic, program-focused research strategy for decision makers. *PerformanceImprovement Quarterly*, 1(3).

Gilbert. T.F. (1978). Human competence: engineering worthy performance.New York: McGraw Hill.

Gilbert, T.F. (1982). A question of performance - part I: The PROBE model. *Training and Development Journal*, September, 21-30.

Gilbert, T.F. (1982). A question of performance - part II: Applying the PROBE model. *Training and Development Journal*, October, 85-89.

Gilbert, T.F. (1991). Personal Interview. Hampton, New Jersey.

Johnson, G. (1896). *Research methodologies for economists*. New York: McMillan.

Patton, M.Q. (1981). *Creative evaluation*. Beverly Hills, CA: Sage.

Patton, M.Q. (1982). *Practical evaluation* (p.35). Beverly Hills, CA: Sage.

Raizen S. & Rossi, P. (Eds.). (1981). *Program evaluation in education: When? How? To what ends?* Washington, DC: National Academy of Science.

Scott, D. & Deadrick, D. (1982). The nominal group techniques. *Training and Development Journal*, June, pp. 26-33.

Struening, E.L. & Guttentag, M. (Eds.). (1975). *Handbook of evaluation research*. Beverly Hills,CA: Sage.

Title:

Effects of Levels of Personalization on Reading Comprehension

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Abstract

Personalization of word problems in mathematics has been used to increase student motivation and comprehension. Similar techniques may be effective in other disciplines. In the present study computer techniques allowed integration into stories of personalized referents from an inventory of student interests. Stories were produced at three levels of personalization. Students read three stories, one per day. A randomized block design was used to determine the order for level of personalization presentation. A quiz was administered after each story to assess student comprehension. Continuing motivation was assessed using a post project survey which included choice of the level of personalization to be used for a fourth story. Scores were analyzed using ANOVA. Achievement mean scores for the individually personalized treatment were higher than either of the other treatments and statistically significant. Results show that personalization of reading materials can increase student comprehension of materials read.

Effects of Levels of Personalization on Reading Comprehension

Reading comprehension has been a topic for research since the early 1900's when Thorndike concluded that comprehension is thinking and relies on inferential processing (Wilson, 1979). Researchers have continued to study reading as a process, examining characteristics of good readers and poor readers (Beveridge & Edmundson, 1989; Gagné, 1985; Levin, 1973), looking at possible causes for reader's problems, including possible sex related differences (Asher & Gottman, 1973; Asher & Markell, 1974; Beyard-Tyler & Sullivan, 1980; Dwyer, 1973; Edwards, 1981; Marshall, 1984) and motivational factors (den Heyer, 1981; Herndon, 1987; Kinzie & Sullivan, 1989).

In the area of mathematical word problems, personalization has been shown to increase comprehension as well as motivation. Anand and Ross (1987) found that personalized treatments for mathematical word problems promoted higher achievement scores on tests involving context, transfer and recognition tests. Eighth grade Hispanic students in a personalized treatment group scored significantly higher on the constructed-response post-test for one-step and two-step mathematical word problems than those in the standard treatment group. Significant interactions revealed that the overall difference favoring personalization was due primarily to its greater effectiveness with boys (López & Sullivan, 1991). Adaptation of instructional materials to students background was used by Ross, McCormick, Krisak, and Anand (1985) to increase the meaningfulness of the materials produced. The adaptations used by Ross yielded substantial mean score gains on mathematical word problems over scores on unmodified materials.

Bracken (1982) personalized stories taken from a commercially produced reading system and found that poor readers did better on tests of personalized versions of the stories than did poor readers who read the unmodified stories. Poor readers' scores showed substantial increases when compared to the scores of those who read the stories in the standard, unmodified form. No difference was found among scores for children of average reading ability on this variable.

If personalization works, then why don't we use it more? Probably the best answer to this question is that personalized materials have been difficult to produce. Creating a unique version of a story for each student in class is harder than creating one story and duplicating sufficient copies for all students to read. Bracken (1982) suggested that for conventional classroom use a level of personalization might be achieved by incorporating the names of several classmates in a single story rather than creating separate stories for each student. Within the time period of Bracken's research, microcomputers were just beginning to become available, and under typical conditions each story would have been individually typed.

Ross and Anand (1987) call for the automation of materials preparation which incorporates personalization. A portion of the present project was designed to accomplish that goal. As in other studies involving personalization, a student biographical survey was used to gather information relative to each student. After entering these items into a file, a computer mail merge was used to combine the story line with referents from the student data file. The strategy developed in this study allows for flexible placement of any or all items and also provides branching to alternate passages based on the contents of any item of the student data file.

Students' reading scores from the grade 8 testing with the Iowa Basic Skills Test determined placement in Chapter I reading classes. Additional test scores in reading prior to participation in the project (ninth grade, lower quartile in reading on a nationally normed test) established the eligible pool of students. A second group of students came from two Communications Classes (eleventh grade, two reading grade levels below class). Thus, the participating students were from a sample of "poor readers" from grades 9 through 11.

The purpose of the project was to examine the effectiveness of three different levels of personalized reading materials on student reading comprehension and to initiate a systematic method for creating personalized reading materials for one or more students using existing computers and software.

Level of personalization and gender of subject were used as the independent variables. Individual scores on thematic tests after each story were used as the dependent measure of student comprehension.

Method

Subjects

Twenty-six students in the ninth, tenth, and eleventh grades from a suburban high school in the southwestern United States were included in this study. The students were in four classes taught by two teachers. Subjects were in two Reading classes (n = 8), and two Communication classes (n = 18). Both the eight reading subjects and the 18 communication subjects were balanced evenly by gender for a total of 13 boys and 13 girls. The students in the Reading classes and in the Communication classes were also identified as "At Risk" students due to achievement and attendance histories.

Materials

A 20-item biographical questionnaire was used to collect personal information from each student. Included were questions asking for names of friends who are boys, friends who are girls, favorite color, sports participated in, and favorite foods. Other questions asked about classes students liked most and least. Question selection and phrasing were substituted to maximize the likelihood that all participants would be able to answer each question easily and minimize situations where no answer was possible for an individual. For example, one question asked for the name of a favorite relative, rather than the name of a favorite aunt (or uncle, etc.), since all students have relatives, but not all students might have an aunt or other specific relative.

Three short stories were created. The first person narrative stories dealt with daily school experiences common to high school students. By replacing key words with appropriate personalized referents, one of the three levels of personalization was incorporated into each story. The stories were modified as necessary to achieve a consistent sixth-grade reading level as measured with the Fry Readability Formula (Fry, E. A., 1968).

Three levels of personalization were used in the study; non-personalized, group personalized, and individually personalized. The three levels were selected to represent three common levels of personalization that might be used with materials read by students in a classroom.

The non-personalized version of the story used nouns and pronouns such as teacher, car, and my friend. The stories were approximately 400 words in length and were printed in a two-column format on one side of an 8 1/2 x 11 inch paper.

The group personalized level was created by substituting the highest frequency item by classroom for each question on the student surveys, replacing selected nouns and pronouns in the story. For example, the sentence "My friend and I went to see a movie." becomes "Ricky and I went to see Dances with Wolves." "Ricky" and "Dances with Wolves" had the highest response frequency in the student surveys.

In the individually personalized version the structure was similar, however, referents from the individual student's inventory were used for merging with the story shell. The non-personalized sentences, "Sunday wasn't too exciting, but I did get to talk with my uncle for a while and later I talked for about an hour on the phone with a friend. We had dinner while we watched TV." became "Sunday wasn't too exciting, but I did get to talk with uncle Carl for a while and later I talked for about an hour on the phone with Chrissy. We had pizza for dinner while we watched The World's Funniest Home Video's." The name of a particular student's favorite relative, a friend who is a girl, favorite food, and favorite TV show were incorporated into the story. In the highly personalized version, each student's story was unique, using referents from that student's own inventory.

The stories were adjusted so that each contained thirty placeholders for referents of generic, group personalized, or individually personalized items.

Each story was followed by a quiz. None of the questions asked for information that would come from student inventory items nor were any questions based on opinion. The questions were content-dependent and required comprehension of the unchanging (non-referent) elements of the story.

Procedures

Students completed a 20-item biographical inventory during their reading class one week prior to reading the first story. Teachers were informed of the necessity to have all items filled in and to tell the students that the information would be used to construct stories that the students would be reading the following week.

The students read one story per day during the last 15 minutes of their reading class. In order to guard against any influence for order of presentation of treatments, the three levels of personalization were blocked so that each possibility of order of presentation was distributed randomly and equally among the students. After reading the story, students completed the ten-item quiz without referring back to the printed story.

Upon completion of all three stories, students again received copies of the three stories they had read and were asked to choose the level of personalization they preferred for a fourth story. The attitudinal survey asked questions about how the students liked the stories, and whether they would like to read more stories personalized at levels similar to the ones they had read. One question asked which story they liked least. An open-ended question asked why the student selected each story identified by the student as liked or disliked.

All quizzes used in the study were scored by a single checker. The answer sheets carried no indication of level of personalization for story presentation.

Criterion Measure

The student's number correct out of 10 questions on each of the three constructed response, thematic quizzes was recorded as a measurement of student comprehension.

Design and Data Analysis

The experimental design was a 3 (personalization) x 2 (gender) factorial repeated measures design.

Results

Mean scores for personalization of reading materials were as follows: individually personalized 8.26, group personalized 6.19, and non-personalized 5.61. A one-way repeated measures analysis of variance was performed to test for differences related to level of personalization (personalized, group personalized, or non-personalized) on story quizzes. The obtained F ratio was statistically significant, $F(2, 77) = 2.52$, $p < 0.001$, with an eta^2 value of .26. A Tukey HSD test revealed that the scores were significantly higher when the story was individually personalized than when it was either group personalized or non-personalized , but that the means for group personalized and non-personalized did not differ significantly from one another.

The differences for gender and personalization crossed with gender were not statistically significant.

The post-project attitudinal survey indicated that 81% of the students selected an individually personalized version for the fourth story to be read, 15% selected a group personalized story, and seven percent selected a non-personalized story. The post project attitudinal survey question 4 asked why the student liked the personalized story. Twenty eight responses were given noting that the story included friends (several subjects provided more than one response in this category), 15 liked that the story talked about them, and 11 liked that the story included things that the student liked to do. Question 6 asked why the student didn't like the non-personalized story. Sixteen students said it was boring, 15 said it didn't relate to me, and six said the story wasn't true. Results on post treatment quizzes show that students score higher when given individually personalized treatments for each story and that group personalized treatments do not significantly improve scores over non-personalized treatments.

Discussion

Individual personalization clearly had a positive effect on student reading scores. One teacher in the study commented that as the students began to read the first story, he saw a smile come to the face of several students as they read. One of the students who received an individually personalized version of the story spoke aloud, saying that now he knew what the student survey was all about. Subsequently a second student who received a non-personalized version, commented that his story didn't have the names of his friends in it and wanted to know why. At the conclusion of the study, this class asked the teacher if they could keep the personalized stories.

Earlier suggestions that group personalization might be effective were not supported by data gathered in this study. The system used to print all of the stories in the study required additional work to produce the group personalized version because it had to be determined separately which referents had the highest frequency for each class. All stories were printed directly from the computer. A further consideration against group personalization was that a few students objected to being placed into groups, or having certain likes that were not their own used in the story. For example, one referent was for type of music liked. Rap music had the highest referent frequency in one class, and therefore was the inserted referent in the group personalized story for that class. Some students objected, stating strongly that they did not like it when the story made it look as though they liked rap music. Other elements of the story created artificial friendships which some students objected to, usually when cultural or social barriers were crossed.

In a 1986 article on adapting material to student interests, Ross, McCormick and Krisak (1986) state, "A final issue concerns the practicality of the adaptive strategy used. Realistically, few teachers would have the time or inclination to prepare alternative sets of materials to represent different contexts." One possible reason for this type of concern involved the lack of readily available hardware and software to meet the challenge of systematically producing individually adapted materials. The system developed for this project made use of hardware and software commonly available in schools, but requires only a single computer and printer. The printed stories were thus able to be used in normal classrooms without need to schedule computer lab time. For instructors who are not yet comfortable enough with computers and are reluctant to take their classes into a lab setting, this system can be used outside of the classroom and the materials brought to the classroom. Materials created with this system can also be used as homework assignments and do not require the student to have access to a computer.

The benefits of individual personalization of student materials can thus be achieved with minimal investment in computer equipment.

The referents used in the stories were supplied by the students themselves. Inclusion of these items into a story shell that was structured around a familiar setting, the student's own classroom, created a more easily assimilated reading environment. Steffensen, Joag-dev, and Anderson (1979) concluded that "the schemata embodying background knowledge about the content of a discourse exert a profound influence on how well the discourse will be comprehended, learned, and remembered". Since the students supplied parts of the story, they had a personal investment in the product and were motivated to pay more attention to the material.

Further investigation of the effects of this type of treatment is needed to determine if the positive increases evidenced in this study can be sustained over additional treatments. The transfer of any gains in reading comprehension from this program could also be investigated to see if comprehension increased for other materials read, or if the uniqueness of the personalized materials had a limited sphere of motivation.

The strategy used in this study is capable of being expanded to a fully automated system for producing on-demand, highly personalized printed reading materials. With such a system, students could receive materials as they were needed rather than transport a whole semesters worth of materials around as a textbook. This could be structured in a fashion similar to the industrial practice known as JIT - Just In Time inventory control. The strategy could also be adopted to producing text files that could be incorporated into a hypermedia based system capable of presenting on screen reading materials in a variety of settings.

REFERENCES

Anand, P. G. & Ross, S. M. (1987). Using computer-assisted instruction to personalize arithmetic materials for elementary school children. *Journal of Educational Psychology*, *79*(1), 73-78.

Asher, S. R. & Gottman, J. (1973). Sex of teacher and student reading achievement. *Journal of Educational Psychology*, *65*(2), 168-171.

Asher, S. R. & Markell, R. A. (1974). Sex differences in comprehension of high- and low-interest reading material. *Journal of Educational Psychology*, *66*(5), 680-687.

Beveridge, M. & Edmundson, S. (1989). Reading strategies of good and poor readers in word and phrase presentation. *Journal of Research in Reading*, *12*(1), 1-12.

Beyard-Tyler, K. C. & Sullivan, H. J. (1980). Adolescent reading preferences for type of theme and sex of character. *Reading Research Quarterly*, *16*(1), 104-120.

Bracken, B. A. (1982). Effect of personalized basal stories on the reading comprehension of fourth-grade poor and average readers. *Contemporary Educational Psychology*, *7*, 320-324.

den Heyer, K. (1981). Reading and motivation. In J. R. Edwards (Ed.), *The Social Psychology of Reading* (pp. 51-57). Silver Springs, Maryland: Institute of Modern Languages, Inc.

Dwyer, C. A. (1973). Sex differences in reading. *Review of Educational Research*, *43*(4), 455-467.

Edwards, J. (Ed.). (1981). *Language and Literacy*. Silver Springs, Maryland, Institute of Modern Languages, Inc.

Gagné, E. D. (1985). *The Cognitive Psychology of School Learning* . Boston, MA: Little, Brown and Company.

Herndon, J. N. (1987). Learner interests, achievement, and continuing motivation in instruction. *Journal of Instructional Development*, *10*(3), 11-14.

Kinzie, M. B. & Sullivan, H. J. (1989). Continuing motivation, learner control, and CAI. *Educational Technology Research and Developmen*, *37*(2), 5-14.

Levin, J. R. (1973). Inducing comprehension in poor readers: A test of a recent model. *Journal of Educational Psychology*, *65*(1), 19-24.

López, C. L. & Sullivan, H. J. (1991). Effects of personalized math instruction for Hispanic students. *Contemporary Educational Psychology*, *16*, 95-100.

Marshall. (1984). Sex differences in children's mathematics achievement: Solving computations and story problems. *Journal of Educational Psychology*, *76*(2), 194-204.

Ross, S. M. & Anand, P. G. (1987). A computer-based strategy for personalizing verbal problems in teaching mathematics. *Educational Communications and Technology Journal*, *35*(3), 151-162.

Ross, S. M., McCormick, D. & Krisak, N. (1986). Adapting the thematic context of mathematical problems to student interests: Individualized versus group-based strategies. *Journal of Educational Research*, *79*(4), 245-252.

Ross, S. M., McCormick, D., Krisak, N. & Anand, P. (1985). Personalizing context in teaching mathematical concepts: Teacher-mananged and computer-managed models. *Educational Communication Technology Journal*, *33*(3), 169-178.

Steffenson, M. S., Joag-dev, C. & Anderson, R. C. (1979). A cross cultural perspective in reading comprehension. *Reading Research Quarterly*, *15*(1), 10-29.

Wilson, M. M. (1979). The processing strategies of average and below average readers answering factual and inferential questions on three equivalent passages. *Journal of Reading Behavior*, *11*(3), 235-245.

Title:

Effect of Color Coding on Cognitive Style

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A considerable amount of research has dealt with the identification of individual differences among learners and how best to approach these differences in developing learning strategies and supporting materials has led to active experimentation and inquiry concerning the role of cognitive-style variables. The usefulness of cognitive style research depends on its potential to identify specific information processing differences between several types of students. Field dependence-independence has been examined more closely than other cognitive styles, no doubt because it describes characteristics which are so directly applicable to the learning process. Measures of field dependence such as the GEFT employed in this study are arguably tests of ability. In fact, the aspect of field dependence-independence that is tapped by the GEFT has been identified as cognitive restructuring ability. There is certainly a strong visual-spatial element in field dependence-independence (Witkin, 1977). For this reason researchers have attempted to design visual instruction according to the characteristics of field-dependent and independent learners, hoping to capitalize on strengths and compensate for weaknesses.

Witkin, et. al. (1977) and his associates have noted that certain individuals interact to superfluous cues in a visualized instructional environment while others are able to identify precisely the critical information contained in a complex visualized environment. These two orientations called field dependence (FD) and field independence (FI) represent two ends of a continuum. Field dependent individuals, when presented a visualized presentation tend not to modify the structure but accept and interact with it as it is presented. They tend to fuse all segments within the visual field and do not view or interact with the visual components discretely. Field independents tend to act upon a visual stimulus, analyzing it when it is organized and providing their own structure when it lacks organization.

The FD/FI cognitive style appears to be especially important in the design of visually related information. Although many studies have examined the effects of visual attributes on learning (Dwyer, 1978, 1987) few have studied the effects of varied visual attributes on specific cognitive learning styles. Research has shown that color coding helps learners organize or categorize information into useful patterns which enables the learners to interpret and adjust to their environment. Color coding may be considered a strategy which students enhance or sharpen essential message characteristics by providing structures for the storage of new information (Dwyer, 1978). Dwyer (1978), in an extensive review of research on the impact of color vs. black and white comparison, found "color versions were to be significantly more effective than the black and white versions in facilitating student achievement of specific educational objectives. These results seem to provide substantial evidence that colors, in fact, are a viable instructional variable" (p. 149). However, a qualification is noted in that color has to be used judiciously and the visuals need to be appropriate for the type of educational objective to be achieved.

It was hypothesized that color coded visuals (Color) would be more effective than black and white coded visuals (B&W) in enhancing the salient visual cues thereby making them more identifiable and instructional to field dependent learners. The color coding would attempt to compensate for the restructuring skills absent in field dependent learners and subsequently lead to deeper information processing and increased achievement. This hypothesis seems plausible since field dependent learners tend to be global in perception and would be most inclined to take advantage of the increased structure provided by the color coding.

However, do color enhanced diagrams also have any effect on retention on verbal tests? Previous studies have investigated the use of B&W and Color coded illustrations to support use of color enhancement over black and white illustrations in answering questions of a verbal nature, i.e., terminology and comprehension (Dwyer, 1968, 1978, 1987). However, there is no research available which investigates the role of color on verbal style questions across the cognitive style known as field dependence (FD), field independence (FI). Additionally, it is not known whether coding (B&W and Color) and field dependence interact or whether color coding positively affects the deficiency of field dependent learners to organize and structure instructional content.

Specifically, the purpose of this study was to examine the effect that coding (B&W and Color) has on the achievement of students categorized as FD/FI learners and to determine if there was any interaction between these variables (field dependency and color) across both visual and verbal oriented tests measuring different educational objectives, namely to learn terminology and basic facts, to identify locations and/or positions, construct and/or understand relationships and to engage in problem solving activities. It was anticipated that the findings of the present study would provide teachers and designers of instructional software with techniques and aids to be used with students possessing different cognitive styles.

Procedures

One hundred nineteen students enrolled in a basic educational psychology course at The Pennsylvania State University participated in this study. Students were classified as field dependent, field neutral, or field independent as a result of their performance on the Group Embedded Figures Test (GEFT), (Witkin, 1971). Students were divided into the different levels based on their mean achievement level on the GEFT. The grand mean achievement by students on the GEFT was 13.08 with a standard deviation of 4.01. Students with one half standard deviation above the mean were considered to be field independent (n = 43, x=17.0, SD = .81); students located one half a standard deviation below were classified as field dependent (n = 29, x= 7.33, SD = 2.11). Students in the middle were classified as neutral FN (n = 45, x=13.17,SD=1.49) (Moore & Dwyer, 1991). Students in the three GEFT levels were randomly assigned to two treatment groups. The subject content for the study consisted of a 2,000 word instructional booklet on the anatomy and functions of the human heart. Each booklet contains 19 illustrations which were designed to illustrate the content being presented verbally. The illustrations in Treatment I, the black and white version, contained black and white coded line drawings which highlighted the information and processes being presented. Students in Treatment II received the same visuals as did students in Treatment I; however, several different colors were used to highlight the information and processes being discussed. The major independent variables in the study were the effect that B&W and Color coding of information had on the information processing strategies of students identified as possessing different levels of field dependence.

Dependent Measures

Each student, after interacting with their respective instructional treatments, received two visually oriented criterion tests. The drawing test required students to draw a representative diagram of the heart and place the number of listed parts (n=20) in their respective positions. The emphasis for this test was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents. The identification, a 20-item multiple choice test, required students to identify the numbered parts on a detailed drawing of a heart. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names. K-R 21 reliability coefficients from the drawing and identification tests were .67 and .80 respectively.

Each student, after interacting with their respective instructional treatments, also received two verbally oriented criterion tests. The terminology test (K-R 21, .83) was a twenty-item multiple choice test which evaluated students' knowledge of facts and terminology and the comprehension test (K-R 21, .88) measured understanding of the internal processes occurring within the heart during the diastolic and systolic phases (Moore & Dwyer, 1991).

Results

A series of two-way analyses of variance were used to analyze the data. The independent variables of color enhancement and cognitive style were tested across each of the four dependent measures (drawing, identification terminology and comprehension tests). An analysis of variance conducted on the drawing test indicated that there was a significant difference in mean achievement for cognitive style (FD/FI), F (2, 111) = 3.99, p < .05.

Field independent students (x = 16.42) scored significantly higher on the drawing test than did field dependent students (x= 12.93) on both the B&W and Color coded treatments. Across all levels of cognitive style (field dependent, field neutral, field independent), students who received the color coded illustrations (x= 17.35) achieved significantly higher scores on the drawing tests than did students who received the B&W coded illustrations (x= 12.24). See Table 1 for mean scores.

On the identification test, field independent students (x = 17.23) achieved significantly higher than did field dependent students (x= 14.41), F (2,111) = 4.51,p < .05. No significant differences in achievement were found to exist on the identification test between students receiving the B&W and Color coded instructional treatments, F (1, 111) = 3.83, p. > .05. Although across all levels of cognitive style, the mean achievement scores of students on the identification who had received the Color coded treatment (x = 16.76) were significantly higher than those who received the (B&W) coded treatment (x = 15.09). See Table 2 for mean scores. When student scores across the drawing and identification tests were combined into a total test both cognitive style mean score (FD/FI), F (2, 111), = 5.00, p. < .05, and Color coding, F (2, 111) = 24.48, p. < .05 were significant.

On the terminology test field independent students (x = 14.54) scored significantly higher in achievement than field dependent students (x= 11.24), F (2, 111) = 5.37, p. < .05. In examining the differences across cognitive style levels, no significant differences in achievement were found on the terminology test between students receiving the B&W and Color coded treatments, F (1, 111) = .65, p. > .05 (Moore & Dwyer, 1991). An insignificant interaction was found to exist between cognitive style and color coding (B&W and Color), F (2, 111) = .29, p. < .05. See Table 3 for mean scores.

As noted earlier, analysis of student achievement on the comprehension test indicated that field independent students (x) = 12.81) scored significantly higher than field dependent students (x= 10.66), F (1, 111) = 3.81, p. < .05. However, no significant differences in achievement were found to exist on the comprehension test between students receiving the B&W and Color coded treatments (Moore & Dwyer, 1991). See Table 4 for mean scores.

On the total criterion test in which all four dependent measures were combined, a significant difference was found to exist among the three field dependence levels, F (2, 111) = 6.29, p. < .05, but significant differences were found to exist between the B&W and Color coded treatments, F (1, 111) = 10.62, p. < .05. No significant interaction was found to exist between treatment type and the three field dependence levels, F (2, 111) = 2.06, p. > .05.

Two secondary analyses were conducted to examine achievement differences occurring among the three field dependence levels when students received only the B&W or Color coded treatments. The one way ANOVA indicated that significant differences existed in favor of the field independence students on all tests; the drawing test, F (2, 58) = 3.78, p. < .05, the identification test, F (2, 58) = 3.83, p. > .05, the terminology, F (2, 56) = 4.19, p. < .05, and comprehension tests, F (2, 56) = 6.81, p. < .05, when they received the B&W coded instructional treatments; however, when making the similar comparison among students receiving only the Color coded treatments no significant differences were found to exist among FD/FI students on the four independent criterion measures [drawing test, F (2, 57) = .60, p. > .05; identification, F (2, 57) = 1.07, p. > .05, the terminology test, F (2, 57) = 1.60, p. > .05, and the comprehension test, F (2, 57) = .98, p. > .05].

Discussion

The results of the experimental study support that the contention that field independent and field dependent learners differ in the cognitive processes they use as well as in the effectiveness of these cognitive processes as measured on tests measuring different education objectives. In the present study, field-independent students scored significantly higher than did field dependent students on the drawing, identification, terminology and comprehension tests (Table 1-4). These results might have been expected since prior research (Moore & Bedient, 1986) have found that field independent learners tend to score higher on criterion measures which require the acquisition of information from visualized instruction and are used to assessing visually complemented instruction. This finding is also consistent with the previous reviews of the literature that have concluded that field independent learners exhibit an active, hypothesis-testing strategy towards learning, whereas field dependent learners tend to employ a more tentative or spectator approach to learning (Goodenough, 1976). Annis (1979), in a study investigating cognitive style on study technique, found that field dependent students did not score as well as field independent students in completing items of high structural importance even when the passage was well organized. The implication being that field dependent students, in addition to receiving a well organized passage, may need explicit structural support to insure that they identify and interact with the critical aspects of the information being presented.

In the present study, significant differences in achievement were found to exist between FD/FI learners on the drawing test. Apparently, the use of color coding of the visualization did not provide sufficient structuring of the critical information to alter the information processing level of field dependent learners on this learning task which required students to construct and/or position the parts of the heart in their appropriate context on the drawing. However, on the identification test no significant differences in achievement were found between FD/FI learners who had received the Color coded treatments. For the type of learning measured by the identification test, Color coding was instrumental in providing the level of learning structure which enabled the FD learners to achieve at a level similar to that achieved by the FI learners. Prior research supports the notion that field dependent learners benefit from the restructuring aspect of instructional strategies (i.e., B&W coding to Color coding), while FI learners are not impeded by imposed structures (Grieve & Davis, 1971; Slatterly &Telfer,1979).

As noted previously, students identified as field independent in this study also achieved significantly higher scores on the two verbally oriented criterion tests than did students identified as field dependents. It appears the field independent learners were able to identify the essential salient cues and impose a more meaningful structure on the perceptual field in relation to the content being presented. Field dependent learners interacted with identical visualized content; however, they only interacted with the visualized instruction (perceptual field) at a superficial level. An inspection of the means achieved on the terminology (Table 3) and comprehension tests (Table 4) by students in the different FD/FI levels indicated that just over 50 percent of the total content to be measured by each criterion test was acquired as a result of the visual coding (B&W and Color) of the instructional content (Moore & Dwyer, 1991).

In analyzing the performance of students who received only B&W coded treatments, it was found that the field independent students achieved significantly greater scores than did the field dependent students on the four criterion tests: drawing, identification, terminology and comprehension. The single color coding strategy (B&W) was not sufficiently strong enough to alter the information processing strategies of the field dependence learners. However, it was expected that the Color coded visuals would make the relevant cues more obvious to the field dependent learners, thereby improving their achievement on the verbal tests. The insignificant results on all four criterion tests did support this contention. Apparently, the Color coded illustrations provided a sufficient structure for the field dependent learners to interact with and internalize at a level similar to that achieved by the field independents. Field independent learners who interacted with the color Coded illustrations may have felt that these illustrations adequately conveyed the intended information and did not utilize their special skills to process the information deeply. For example, the directions to the instructional unit indicated that the unit was designed to help them understand the functions of the human heart. Students, as they preceded through both instructional treatments, may have felt that they understood the content adequately. Performance on the criterion tests between the two groups might have changed significantly if the directions in the instructional booklet had indicated that they would not only have to understand the functions of the human heart but would also have to perform on a test measuring knowledge of terminology and the functions of the various parts of the heart during the diastolic and systolic phases. Possibly, specific directions relating to precise performance expectations would have stimulated the field independent learners to use their special skills to initiate deeper information processing which, in turn, would have led to increased information acquisition.

The results of this study indicate that the concept of field dependence/field independence is an important instructional variable in the teaching-learning process. Color coding was also found to be an effective instructional variable for maximizing the information processing acquisition level for field dependent learners on the types of criterion measures employing visually oriented tests used in this study. The significant interaction on the comprehension test between treatment and cognitive style (FD/FI) found in this study appears to be a spurious finding and needs to be replicated before credibility can be attached to its existence. However, on verbally oriented tests, color coding was not found to be an effective instructional variable for maximizing the information processing acquisition levels across all levels of field dependence.

Note: This paper is based upon a paper presented at the meeting of the International Literacy Association, Washington, DC., October, 1991.

Table 1 - Mean Scores - Drawing Test

Field Dependence		Color		Total
		Color	Black & White	
FI	Mean	17.8	14.50	16.42
	SD	2.57	3.45	3.36
	n	25	18	43
Neutral	Mean	16.96	11.68	14.38
	SD	2.76	3.86	4.24
	n	23	22	45
FD	Mean	17.10	10.74	12.93
	SD	3.28	5.46	5.66
	n	10	19	29
Total	Mean	17.35	12.24	14.77
	SD	2.75	4.54	4.54
	n	58	59	117

Table 2 - Mean Scores - Identification Test

Field Dependence		Color		Total
		Color	Black & White	
FI	Mean	17.32	17.11	17.23
	SD	2.87	2.22	2.59
	n	25	18	43
Neutral	Mean	16.70	14.50	15.62
	SD	3.61	3.64	3.75
	n	23	22	45
FD	Mean	15.50	13.84	14.41
	SD	3.75	4.99	4.60
	n	10	19	29
Total	Mean	16.[illegible]	15.09	15.92
	SD	3.34	3.98	3.76
	n	58	59	117

Table 3 - Mean Scores - Terminology Test

Field Dependence		Color		Total
		Color	Black & White	
FI	Mean	14.48	14.61	14.54
	SD	4.33	3.68	4.03
	n	25	18	43
Neutral	Mean	13.22	12.05	12.64
	SD	3.78	4.08	3.92
	n	23	22	45
FD	Mean	11.80	10.95	11.24
	SD	4.42	4.06	4.13
	n	10	19	29
Total	Mean	13.52	12.48	12.99
	SD	4.18	4.16	4.18
	n	58	59	117

Table 4 - Mean Scores - Comprehension Test

Field Dependence		Color		Total
		Color	Black & White	
FI	Mean	12.28	13.56	12.81
	SD	3.78	4.54	4.11
	n	25	18	43
Neutral	Mean	12.83	8.68	10.80
	SD	3.64	3.81	4.24
	n	23	22	45
FD	Mean	10.70	10.63	10.66
	SD	5.29	4.18	4.50
	n	10	19	29
Total	Mean	12.22	10.80	11.50
	SD	4.01	4.56	4.34
	n	58	59	117

References

Annis, L.F., 'Effect of cognitive style and learning passage organization on study technique effectiveness,' Journal of Educational Psychology, 71, pp. 620-626, 1979.

Dwyer, F. M., Strategies for improving visual learning, Learning Services, State College, PA, 1978.

Dwyer, F. M., Enhancing Visualized Instruction: Recommendations for the Practitioners, Learning Services, State College, PA, 1987.

Dwyer, F. M., 'Effect of varying amount of realistic detail in visual illustrations designed to complement programmed instructions,' Perceptual and Motor Skills, 27, pp. 351-354,1968.

Goodenough, D.R., 'The role of individual differences in field dependence as a factor in learning and memory,' Psychology Bulletin, 83, pp. 675-694, 1976.

Grieve, T.D. and Davis, J.K., 'The relationship of cognitive style and method of instruction to performance in ninth grade geography,' Journal of Educational Research, 65, pp. 137-141, 1971.

Moore, D.M. and Dwyer, F.M. Effect of color coded information on students' levels of field dependence, Perceptual and Motor Skills, 72, pp. 611-616, 1991.

Moore, D. M. and Bedient, D., 'Effects of presentation mode and visual characteristics on cognitive style,' Journal of Instructional Psychology, 13, pp. 19-24, 1986.

Slatterly, D.J. and Telfer, I.G., 'Cognitive style and advance organizers in learning and retention,' British Journal of Educational Psychology, 49, pp. 69-178, 1979.

Witkin, H. A., Oltman, P. K., Rashin, E. and Karp, S. A., A manual for the group embedded figures test, Consulting Psychologists Press, Inc., Palo Alto, CA, 1971.

Witkin, H. A., Moore, C. A., Goodenough, D. R. and Cox, P. W., 'Field-dependent and field-independent cognitive styles and their educational mplications,' Review of Educational Research, 47, pp. 1-64, 1977.

Title:

The Use of Instructional Design Skills in the Mental and Written Planning Processes of Teachers

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The Use of Instructional Design Skills in the Mental and Written Planning Processes of Teachers

Fingers in the Dike

Public schools in particular and education in general have been widely criticized in recent years. Although criticism is not new in the field of education, current critics are focusing their concerns on the "products" of education--our children--and the skills they seem to lack. The feeling is that our nation is at risk because of our students' lack of preparation for entering the work force. Our "once unchallenged preeminence in commerce, industry, service, and technological innovation is being overtaken by competitors throughout the world" partly because of the "rising tide of mediocrity" in the schools (National Commission on Excellence in Education, 1983, p. 5). Such international comparisons highlight deficiencies in our current educational system.

Over the years such criticism has generated both beneficial and detrimental changes in our approaches to education. In response, the educational pendulum has swung excitedly from one extreme to the other, advocating this program or that activity to solve the educational dilemma. However, this bandwagon approach, rather than providing valid solutions to the problems, merely administers "band-aid" treatments to the symptoms.

This prevalent quick-fix mindset reminds me of a favorite story from one of my elementary school readers. A little Dutch boy who lived in the flood-prone lowlands of Holland discovered a small leak in one of the protective dikes which held back the waters of the North Sea. Although only a dribble was visible, he knew that, before he could summon adult help, the water would have eroded a large, destructive opening in the earthen bank. So he took the only practical action possible in those circumstances--he stuck his finger in the hole in the dike and stopped the leak--and thus averted a life-threatening deluge of water from destroying his village. His courageous stop-gap action, though effective, was merely a temporary measure. Eventually the dike had to be rebuilt and strengthened to avoid future deterioration.

It is thus with education and the public schools. There are just too many courageous, dedicated teachers, parents, students, and administrators with their "fingers in the educational dike"--with little hope of developing a strong and effective system as long as their efforts are concentrated on symptoms rather than causes.

What are the causes of the apparent failure of our children to meet the criteria for acceptable performance? Have we lost sight of our goals? Is the pursuit of excellence too difficult? Do we need increased budgets and salaries? Are our teachers only mediocre? Are our curricula outdated or unrealistic? Answers to questions such as these will be found as we adopt a new perspective for the public schools--a change from the traditional myopic "finger-in-the-dike" approach which has pervaded education for generations to a focus on human performance.

It is indeed time to break out of the current mediocrity cycle which continues to produce students who lack adequate preparation for the work force as we move from an industrial to an information and service age. Educational technology is the catalyst for this change. No, I don't mean that we merely need more computers in the classrooms. Technology involves process. It is the *system* which requires our attention. Too often our efforts to improve education have resulted in an unrealistic isolation of technological tools (e.g., interactive video, hypermedia, and computers) from the technological system or process. For example, although a recent report of a National Education Association committee discusses the significant ways in which technological innovations will significantly improve educational opportunities and warns against a piecemeal approach, their emphasis is still on "things" (hardware and software) rather than process (NEA Special Committee Report, 1989). Remember educational television in the 60's? We expended our entire resources on installing equipment which soon began to gather dust because we neglected the process component. Don't get me wrong. I do believe that such tools are indeed valuable resources, but only when used in an effective system which develops human competence, only when used in the systematic design of instruction. Until such a system is in place, promoting one tool or another is simply adding more fingers to the dike.

Technology as Process: Using ID Skills

Technological changes in teacher preparation programs have emphasized instructional design theory as a vehicle for improvement (Reiser, 1988; Shrock & Byrd, 1988; Schiffman, 1988; Knirk, 1988; Earle, 1985). Although this is a valuable framework for preparing teachers, it is not widely used in teacher education programs (Schiffman and Gansneder, 1987; Rossett and Garbosky, 1987; Earle, 1989). "Except for a brief spurt of activity in the early 1970s, instructional designers have not played a major role in higher education or in the public schools" (Reiser, 1988, p. 5).

A recent survey of graduate programs in instructional technology (Schiffman & Gansneder, 1987) attempted not only to identify characteristics of such programs but also to outline their involvement in teacher education or the public schools. Although many programs offered media and computing courses for teacher education majors, those specializing in instructional design tended to offer no ID courses for teachers. The same survey also indicated that ID faculty are less likely to participate in teacher education planning or to have formal ties with schools than those in the media and computing areas.

The rift between theory and practice is obvious - particularly in an area where the design of appropriate instruction is critical: the schools and the teachers in those schools. The challenge is equally as obvious - bridging the gap so that instructional design theory is part of a teacher's repertoire.

Teaching Planning

Planning can be viewed from two perspectives--as a blueprint or as a process (Yinger, 1979). McCutcheon (1980) considered the complex, reflective mental dialogue which is prerequisite to written plans as by far the "richest form of teaching planning" (p. 7).

The teacher planning literature has attended in the past to the categories of planning (which, in many ways resemble the steps in the ID process), the time frames of planning, and the products or processes of planning. (McCutcheon, 1980; Clark & Yinger, 1979; Morine-Dershimer, 1978-9; Peterson, Marx, & Clarke, 1978; Zahorik, 1975). More recent research has emphasized the practical applications of ID skills in the planning processes of teachers (Reiser & Mory, 1991; Klein, 1991; Martin, 1990; Martin & Clemente, 1990).

This study focusses not only on differences and similarities between the written product and the mental process of teacher planning, but also on the systematic framework used by teachers in this process.

The UNCW Program

The undergraduate teacher education program at the University of North Carolina at Wilmington has had an instructional design component since 1976 (Earle, 1985). This component involves a two-semester sequence with the first course concerned with instructional design and the second course the study of classroom evaluation. In our ID course, we emphasize the importance of a systems approach to planning instruction and teach our students fundamental concepts, principles, and skills (at a basic level) of instructional design. In the companion evaluation course, we continue to use an ID model to provide a meaningful context for classroom evaluation, emphasizing the interdependence of instructional decisions and evaluation decisions. We are primarily interested in teaching our students a practical, systematic process to use when planning instruction, together with the necessary ID principles and skills for producing technically sound, teacher delivered instruction. Thus, our courses are designed to enhance the application of instructional design for teachers.

From the beginning, our aim has been to develop applications of the instructional design process that would serve the planning of teacher delivered instruction, rather than materials-based instruction. We have never envisioned our goal as preparing preservice teachers to be full-fledged instructional designers in the schools, but rather to develop teachers who can apply a systematic process for developing more effective instruction, especially where the teacher is likely to be the centerpiece of instructional delivery. At the same time we have taken the view that all of the major steps in a generic ID model and the basic skills associated with them can be taught at the undergraduate level and do have value for the classroom teacher. Support for this view can also be found in writings by Beilby, 1974; Stolovitch, 1980; Dick and Carey, 1985; Dick and Reiser, 1989; Martin & Clemente, 1990; and Reiser & Mory, 1991.

At UNCW the instructional design component of the curriculum is intended to provide students with a particular way of thinking about and planning instruction. We have attempted to create a teacher education program (not merely a single course) that promotes the adoption and development of a systematic approach to instruction. Consequently, the entire program, at least ideally, is designed to support the application of instructional design skills and principles to teaching. Methods instructors and practicum supervisors are expected to support the further development of students' ID skills initially acquired in the instructional design course. Of course, we do find that certain ID concepts and skills are better understood, receive greater emphasis, and are better maintained over the course of the program than are others. Not surprisingly, those aspects that are most easily transferred to the day-to-day activities of teachers get emphasized. In addition to Gagne's taxonomy and the events of instruction, objectives receive continued emphasis (although typically in abbreviated form), as do learner analysis and criterion referenced testing practices.

Purpose

This study continues to investigate the effects of preservice ID skills on classroom practice. Do graduates of our program actually use the ID skills we teach them? If so, how? If not, why not? Are they modified in practice?

In particular, the study focuses on the relationship between teacher mental planning and ID skills for our graduates. Clemente and Martin (1990) have outlined a comparison of ID components and teacher mental planning which attempts to link ID theory with classroom practice. Although much has been written about the teacher planning process (Yinger, 1979; Morine-Dershimer, 1978-79; McCutcheon, 1980; Clark & Peterson, 1986), we in the instructional design field seem to have neglected a valuable body of research. This study attempts to not only show the value of ID skills for preservice teachers, but also link those skills with teacher mental planning.

Process

We identified recent graduates (1980-1990) from our undergraduate preservice teacher education programs. We asked them to respond to a four-part survey which covered demographics, general information, yearly planning, unit planning, and daily planning. Similar questions addressed each aspect of planning. A randomly-selected group received two surveys with instructions to share one with colleagues who had not graduated from UNCW. The survey was adapted from instruments developed by Barbara Martin and Robert Reiser.

The second phase of the study involved interviewing teachers in more detail to flesh out the initial findings from the survey and to explore further the process of mental planning.

Phase I: Initial Findings and Opportunities for Reflection

A review of the data has resulted in the following observations. Tables 1-8 provide a more detailed summary of the survey responses. These areas are explored further in the follow-up interview phase of this study.

1. 81% of teachers felt that a knowledge of ID processes had improved their planning (6% No; 13% Not Sure).

2. The crucial elements of the ID process were goals, learner analysis, objectives, tests, activities/strategies, and revision of instruction. These were also the areas treated formally by teachers. Those elements considered helpful (if time allowed) were task analysis, classification of learnings, instructional plans, and trying out instruction. These were treated informally and usually implemented through mental planning. Of particular interest was the fact that instructional plans were found to be helpful but not crucial.

3. Written plans focused more on objectives and tests and to a lesser degree on activities...but not on instructional plans. It appears that use of written plans may be affected by administrative requirements.

4. Unit planning concentrated on goals, learners, objectives, tests, and strategies. Daily plans emphasized learners, objectives, strategies/activities, instructional plans, and revision of instruction. Objectives were also stressed at the yearly level. Of particular interest, and perhaps expected, was the low response to trying out instruction...treated informally and mentally and considered helpful if time allowed.

5. Although teachers regarded mental and written planning as almost equal in importance at the yearly, unit, and daily levels, they favored mental planning overall.

6. Teachers deviated more from yearly plans and less from unit and daily plans. Daily and unit planning were viewed as more important.

7. 66% of teachers indicated that more than 50% of their unit planning resulted in written plans. 47% responded that they wrote more than 50% of their daily plans.

8. Content took more time at the yearly level and least at the daily level. Slightly more time was given to materials in daily planning. More time was spent on activities at the unit and daily level. Tests took equal time at all levels. More time was allocated to objectives at the yearly level.

Phase II: Spontaneously Systematic or Systematically Spontaneous?

The following comments were gathered from in-depth interviews with teachers in which we discussed their planning before, during, and after the school year. I have grouped representative quotes into three major areas--time frames of planning, the framework or systematic approach to planning, and the mental processes of planning.

Time Frames.

Teachers do indeed plan in different time frames with varying emphases at each level.

1. Yearly Planning

- I sit down at the beginning of the year and ask 'what do I want to accomplish?'
- I plan for the year in chunks, correlating with the science and social studies teacher.
- The timelines are in my mind...basically mental...I don't write down the scope and sequence.
- I think back on what worked last year and what didn't.

2. Unit Planning

- I map it out in home base...with monthly themes and activities.
- A monthly calendar on PrintShop...a packet with objectives, times, material lists, activities, and assessment or evaluation ideas.

3. Daily Planning

- A notebook with a lesson outline including...objective, focus and review, teacher input, guided practice, independent practice, and closure.
- I like to see four weeks at a glance...in each daily block I use shorthand...a rough sketch of what I want to do...not a lot of detail.
- Every class is at a different point...notecards...a record of where they're at. There's a lesson plan laid out...this is where I want to be and want to do.

Systematic Framework

There is adequate evidence that teachers approach their planning in very systematic ways, emphasizing at least the following ID skills.

1. Learner Analysis

- We really plan as to how we see the needs of the children.
- The reactions of the students actually helped me in my planning for the next time I taught this.
- I try to know my kids, their minds, who they are. Test scores are available for reference.
- I look at the children and try to understand where they're coming from.
- I don't like to have a preconceived idea...although I do want to know if there are problems in their lives.
- I use their cumulative folders and sometimes talk to other teachers, especially to see what worked well for the child in other classes.
- I've got to watch MTV, read the newspaper, do all this stuff to bring in what's really relevant and fun to these kids, or I'm going to lose them.

2. Objectives

- I use the list of competency goals and indicators as a checklist...as we accomplish them it's a guide to progress.
- Objectives and goals drive my curriculum.
- I tell them everything has a purpose, everything has a goal, everything has an objective and an ultimate end to it and you have to know what that is when you go through the whole process.

3. Tests

- I set out with the goal of what I want the students to achieve and learn...don't make out the test till maybe the third week of the unit...want to see what concepts are being grasped...to see how comfortable and competent they are.
- I have to know if I've given them enough practice. What is the best item format for them?
- I can measure their performance only if there's been sufficient instruction and practice.

4. Instructional Strategies

- I brake for the teachable moment...I am spontaneous...use ideas on the spur of the moment.
- Most of my planning time I'm working on how to get things across to the kids.
- When the kids begin telling you what they'd like to do...when they understand the purpose...then you can really start envisioning.
- The content varies but the system or framework is constant.
- I follow a six step lesson plan--objectives, focus and review, teacher input, guided practice, independent practice, and closure...this is my framework.
- I use different materials depending upon current events, but the concepts and objectives remain the same.

5. Formative Evaluation

- I don't keep my lesson plans from year to year. It really changes. Every year's different--my kids are different--what's going on is different--the world is different.
- I think about what worked and what didn't.

The Process: Mental Imagery

The following statements by teachers certainly support McCutcheon's funding that "much of [teaching planning] never appeared on paper...[but] resembled a rehearsal of the lesson, an envisioning of what would happen." (1980, p. 7)

- I visualize my classroom...mentally see it...like playing a videotape.
- I had to get it down on paper while I had it envisioned.
- We're thinking these things in our minds...seeing them.
- I don't get much sleep in August. I envision...I'm designing my classroom...doing a bulletin board...teaching a lesson. It's visual. I can actually see it in my mind.
- If I've envisioned it--how it's going to go--it's almost as if I've done it before--I'm trying to relive what I've seen.
- If there's a glitch in the lesson, it's like static on the video.
- I "see" potential problems as well--I look at the best and the worst.
- Even while I'm teaching...just like something jumps out at you...I can see what I'm

going to do.

- Sometimes I don't write lesson plans...but my classes were clicking...I had the plans in my mind...It worked because of my internal framework.
- I like to see things systematically done and I'm going over them in my mind, putting all the visual pieces together.

A Few Concluding Thoughts

This is exciting stuff--bridging the gap between theory and practice. This is where our future lies as instructional designers--developing collegial relationships with front line practitioners. We can help teachers apply ID skills because, as one teacher observed: "Once we get the framework, the system, we're constantly using it and revising it." This is where we can really make a difference in transforming education, in ensuring successful performances by our students, in meeting the challenge to break out of the mediocrity cycle.

Table 1: Formal and Informal Use of ID Processes

	Formal	Informal
a. develop or review course and unit goals	67%	33%
b. develop a task analysis or learning hierarchy to identify prerequisite skills and sequence	33%	67%
c. classify types of learning indicated in the content	17%	83%
d. analyze the abilities and needs of learners	75%	25%
e. develop performance and/or behavioral objectives	75%	25%
f. develop tests that match the learnings described in the objectives	67%	33%
g. select or produce learning activities and strategies that match the type of learning and objective	71%	29%
h. follow a systematic instructional plan (e.g., Gagne's events of instruction, the N.C. six point plan, or Madeline Hunter's steps, etc.)	60%	40%
i. try out the instruction prior to using it in the classroom	8%	92%
j. revise the instruction based on the results observed during teaching	53%	47%

Table 2: Written or Mental Plans

	Written	Mental
a. develop or review course and unit goals	56%	44%
b. develop a task analysis or learning hierarchy to identify prerequisite skills and sequence	29%	71%
c. classify types of learning indicated in the content	19%	81%
d. analyze the abilities and needs of learners	39%	61%
e. develop performance and/or behavioral objectives	74%	26%
f. develop tests that match the learnings described in the objectives	76%	24%
g. select or produce learning activities and strategies that match the type of learning and objective	60%	40%
h. follow a systematic instructional plan (e.g., Gagne's events of instruction, the N.C. six point plan, or Madeline Hunter's steps, etc.)	53%	47%
i. try out the instruction prior to using it in the classroom	14%	86%
j. revise the instruction based on the results observed during teaching	55%	45%

Table 3: Use of ID Processes in Yearly, Unit, and Daily Planning

	Year	Unit	Day
a. develop or review course and unit goals	50%	70%	30%
b. develop a task analysis or learning hierarchy to identify prerequisite skills and sequence	30%	45%	25%
c. classify types of learning indicated in the content	10%	25%	35%
d. analyze the abilities and needs of learners	30%	50%	65%
e. develop performance and/or behavioral objectives	40%	45%	45%
f. develop tests that match the learnings described in the objectives	10%	55%	35%
g. select or produce learning activities and strategies that match the type of learning and objective	20%	55%	70%
h. follow a systematic instructional plan (e.g., Gagne's events of instruction, the N.C. six point plan, or Madeline Hunter's steps, etc.)	10%	35%	70%
i. try out the instruction prior to using it in the classroom	10%	20%	25%
j. revise the instruction based on the results observed during teaching	30%	55%	75%

Table 4: The Value of ID Processes

	Crucial	Helpful	Unimportant
a. develop or review course and unit goals	67%	33%	0%
b. develop a task analysis or learning hierarchy to identify prerequisite skills and sequence	25%	67%	8%
c. classify types of learning indicated in the content	17%	50%	33%
d. analyze the abilities and needs of learners	92%	8%	0%
e. develop performance and/or behavioral objectives	83%	0%	17%
f. develop tests that match the learnings described in the objectives	75%	17%	8%
g. select or produce learning activities and strategies that match the type of learning and objective	83%	17%	0%
h. follow a systematic instructional plan (e.g., Gagne's events of instruction, the N.C. six point plan, or Madeline Hunter's steps, etc.)	17%	75%	8%
i. try out the instruction prior to using it in the classroom	0%	75%	25%
j. revise the instruction based on the results observed during teaching	67%	33%	0%

Table 5: Importance of Written and Mental Plans

	Written	Mental	Equal
Overall	25%	37.5%	37.5%
Year	31%	31%	38%
Unit	29%	7%	64%
Daily	33%	27%	40%

Table 6: Following Plans

	Year	Unit	Daily
Very Closely	8%	8%	13%
Closely (< 25% deviation)	46%	77%	67%
Somewhat Closely (25-49% deviation)	31%	15%	20%
Somewhat Loosely (50-75% deviation)	15%	0%	0%
Very Loosely (> 75% deviation)	0%	0%	0%

Table 7: Importance of Planning

	Year	Unit	Daily
Crucial (100% of the time)	23%	31%	60%
Useful (75% of the time)	46%	69%	40%
Generally Useful (50% of the time)	31%	0%	0%
Minimally Useful (25% of the time)	0%	0%	0%
Not Very Useful (< 10% of the time)	0%	0%	0%

Table 8: Amount of Written Planning

	Overall	Year	Unit	Daily
More than 75%	29%	33%	33%	27%
50% - 74%	18%	20%	33%	20%
25% - 49%	35%	27%	27%	33%
Less than 25%	18%	20%	7%	20%

REFERENCES

Beilby, A. E. (1974). Instructional development in the public schools: Whose job? Educational Technology 14(1).

Clark, C.M. & Peterson, P. L. (1986). Teachers process. In M. C. Wittrock (Ed.), Handbook of Research on Teaching (pp. 255-296). New York: MacMillan Publishing Company.

Clark, C.M. & Yinger, R.J. (1979). Three studies of teacher planning. (Research Series No. 55). East Lansing, MI: Michigan State University, Institute for Research on Teaching. (ERIC ED175-855).

Clemente, R. & Martin, B. (1990). A comparison of teacher mental planning elements and instructional system design components. AECT Paper.

Dick, W. & Carey, L. (1985). The systematic design of instruction, 2nd ed. Glenview, IL.: Scott, Foresman and Company.

Dick, W., & Reiser, R. A. (1989). Planning effective instruction. Englewood Cliffs, NJ: Prentice Hall.

Earle, R. S. (1985). Teachers as instructional designers. Educational Technology, 15 (8).

Earle, R. S. (1989). Instructional design theory in teacher education: A survey. Wilmington, N.C.: The University of North Carolina at Wilmington.

Klein, J. D. (1991). Preservice teacher use of learning and instructional design principles. Educational Technology Research and Development, 39(3), 83-89.

Knirk, F. G. (1988). Implications of instruction technology for the future of education. Journal of Instruction Development, 11 (3), 10-15.

McCutcheon, G. (1980). How do elementary school teachers plan? The nature of planning and influences on it. The Elementary School Journal, 81, 1, 4-23.

Martin, B. L. (1990). Teacher's planning processes: Does ISD make a difference? Performance Improvement Quarterly, 3(4), 53-73.

Martin, B.L. & Clemente, R. (1990). Instructional systems design and the public schools. Educational Technology Research and Development, 38(2), 61-75.

Morine-Dershimer, G. (1978-79). Planning in classroom reality and in-depth look. Educational Research Quarterly. 3, 4, 83-99.

Peterson, P.L., Marx, M.W., & Clarke, C.M. (1978). Teacher planning, teacher behavior, and student achievement. American Educational Research Journal, 15(3), 419-432.

Reiser, R. A. (1988). Instructional designers in public schools and higher education: Predictions for the year 2001. Journal of Instructional Development 11(3), 3-6.

Reiser, R.A. & Mory, E.A. (1991). An examination of the systematic planning techniques of two experienced teachers. Educational Technology Research and Development,39(3),71-82.

Rossett, A. & Garbosky, J. (1987). The use, misuse, and non-use of educational technologists in public education. Educational Technology, 27(9), 37-42.

Schiffman, S. S. and Gansneder, B. M. (1987). Graduate programs in instructional technology: Their characteristics and involvement in public education. Journal of Instructional Development, 10(5), 22-28.

Schiffman, S.S. (1988). Influencing public education. A "window of opportunity" through school library media centers. Journal of Instructional Development, 10(4), 41-44.

Shrock, S.A. & Byrd, D.M. (1988). An instructional development look at staff development in the public schools. Journal of Instructional Development, 10(4), 45-53.

Stolovitch, E. J. (1980). Instructional technology and its challenges to teacher training. N.S.P.I. Journal, 19(6).

Yinger, R. (1979). Routines in teacher planning. Theory Into Practice. 18, 3, 163-169.

Zahorik, J.A. (1975). Teachers' planning models. Educational Leadership, 33(2), 134-139.

Title:

Systematically Designed Text Enhanced with Compressed Speech Audio

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Currently there is a high-paced search for the perfect medium. One that delivers instruction so that learning is effective and efficient. Is it possible that with all the focus on "high-tech," one viable solution is being overlooked? Audio tapes are one of the most popular forms of entertainment we have today. Just walking down the street you see many people "plugged in." Audio is also increasingly being used for instruction because it is inexpensive, convenient, and portable. Unlike text, audio provides a human touch to instruction. The voice can motivate the learner through the enthusiasm expressed for the subject.

Statement of the Problem

One problem with audio is the time it takes to listen to a program. When involved in a two-way conversation, the average rate of speech is comfortable; with one-way audio, the pace seems dreadfully slow. It has been shown that the human brain can comprehend information that is delivered nearly twice as fast as the original speed of delivery (Carver, 1982). Through the use of speech compression technology, it is possible to accelerate a recorded voice without significant distortion of the pitch or natural quality (Olson, 1985).

Another problem associated with audio programs is that they are just taped versions of books, lectures, or seminars, and like extemporaneous conversation may contain information that is extraneous. It has been shown that the effectiveness of instructional materials can be increased by employing a systematic design process that removes irrelevant information (Mengel, 1982).

Augmenting systematically designed text with audio may help increase learners' attention to the material because of it's steadily paced, non-stop information flow. By using audio along with text, learners maintain the benefit of visual design features. It is possible, since systematically designed materials have a high density of information, compressed speech technology may "over-compress" the instruction. All that may be needed is a normal speech audio tape for pacing. Therefore, this study compared two forms of audio augmentation, normal and compressed speech.

Cognitive Theory

Most individuals have sufficient semantic cognitive capacity to carry on a conversation at a rate of 125 to 150 wpm and responding at about the same rate internally until the response is voiced. If added together, one might theorize that the average semantic cognitive capacity would be about 250-300 wpm. If involved in a one-way semantic communication such as reading, or listening, the cognitive capacity should remain the same. Increasing the input level to 250 to 300 wpm through the use of compressed speech should help keep attention levels high and optimize learning.

Research has shown that the average reading level of most Americans is between 250-300 wpm, with the average college student reading at about 280 wpm (Taylor, 1965). Humans can successfully listen at rates of 250-300 wpm using speech compression technology. Carver (1981), refers to this optimal efficiency rate (300 wpm) of reading or listening (auding) as the "rauding rate." This rate is highly efficient, but somewhat less effective than lower rates when tested using traditionally developed learning materials. Effective comprehension of this type of material begins to decline around 250 wpm using compressed speech (Foulke, 1966).

The evidence strongly indicates that the cognitive capacity of the conscious working memory is limited. Input from the five senses fill it to the limit moment by moment. As the working memory is filled, information is moved to long-term memory or is lost. Humans are constantly being bombarded by biological, physiological, and psychological input, which takes up this limited cognitive capacity. To some extent, humans determine what is placed in the working memory through a process known as selective perception. What we choose to perceive often relates to what Gagne (1985) terms executive controls, made up of the sum of our past experience and future expectations. Selective perception provides attention to those things we perceive as important. Research has shown that attention itself utilizes cognitive capacity. Therefore, to optimize learning, attention to distractions must be reduced and working memory input should be limited to the information required for learning. It is also desirable to fill the cognitive capacity with the learning stimulus at an optimum rate so that distractive thoughts do not have time to enter the working memory.

Examination of the research (Mengel, 1982) shows that systematically designed materials have a higher concept density than traditionally developed materials. In effect, the instruction is already compressed to some extent. It is possible that this would increase the rate of concepts flowing into the working memory requiring less compression from another source to total the cognitive capacity. In fact, designing instruction (increasing density) could create too dense an information flow at rates suggested by past research.

Since the process of attention (or selective perception) itself uses up vital capacity, reducing the need for attention by systematically designing instruction may provide even more capacity for learning. Berlyne (1960) suggests that a higher degree of involvement with learning materials should correlate with a higher degree of recall.

Systematically designed instruction is objectively based so that all of the information is aimed toward mastering the objectives. Practice actively involves the student in the learning process. In addition, redundant information presented in two channels (reading and listening) and using two modes (linguistic and iconic) should create an even higher degree of involvement with the materials, thus increasing learning (Bradtmueller, 1978; Nugent, 1982). If the need for attention is further reduced by providing an environment with a low level of noise, learning should be increased even more (Hsia, 1968). By combining these methods the involvement with the learning materials should be at a maximum level and the effectiveness of higher compression rates should be increased.

Measuring Compression Rates

Research has identified several methods of measuring compression rates. Many studies use a percentage of compression with the original tape defined as 0% and the experimental tapes from 25% to 100% compression. Other studies define the original tape as 100% and the experimental tapes as 125% to 200% compression. The problem with both percentage methods is that the speed of the original tape is usually not stated.

Conversational speed has been measured at 125-150 wpm. Professional voices have been identified as averaging 175 wpm. 25% (or 125%) compression of

125 wpm equals 156.25 wpm, which is barely out of the conversational speech range. 75% (or 175%) compression of 125 wpm equals a 25% (or 125%) compression of 175 wpm which is 218.79 wpm. These large differences make the studies difficult to interpret. What does 1.5 times or 2 times normal speed mean?

Other studies do identify the exact wpm used (Boyle, 1969), but don't always clearly state the rationale behind their choices of experimental speeds. It would seem that in early research it was necessary to experiment with a variety of speeds; with a more solid research base, compression rates can now be deliberately chosen.

Bradtmueller (1978) states that "It is theoretically possible to speed up tapes to any rate but the human hearing mechanism begins to have difficulty processing messages somewhere between 300 and 500 words per minute" (p. 4). Acceptable comprehension occurs up to 300 words per minute and is most efficient at that level (Carver, 1982; Sticht, 1968). Given discretionary control over the rate of presentation, students prefer to work at a rate around 225 wpm, well below the limits of their capabilities (Lass et al., 1974; Foulke & Sticht, 1967).

The four rates have appeared in the research that are of interest:

175 wpm - This is the approximate rate reportedly used by professionally trained readers (Foulke, 1966). It is still within the normal speech range. Media sophistication has probably acclimated most people to this rate of speech. Rates below this level were not chosen or ranked very highly by subjects (Lass et al., 1974; Orr et al., 1969). Slow speakers generate negative evaluations by the listeners, whereas fast speakers are described as fluent, persuasive, and credible (Apple, Streeter, and Krauss, 1979; Miller et al., 1976).

225 wpm - This is the rate reported to be preferred by learners (Lass et al., 1974; Foulke & Sticht, 1967; Orr et al., 1969). At this rate learners are working below their abilities (Foulke & Sticht, 1967). It is 29% compression of 175 wpm.

262 wpm - This rate is a half-way point between 225 wpm and 300 wpm. It is also a 50% compression level for 175 wpm. In a study of radio advertising using professionally made recordings, LaBarbera and MacLachlan (1979) state: "As long as the speech is not speeded up by more than 50% the listener will be unaware that there has been an electronic alteration of the original recording" (p. 30). Some studies show (Foulke, 1966) comprehension of traditional materials begins to decline somewhere between 250 wpm and 300 wpm.

300 wpm - This rate consistently appears in the research as the top end level for efficient comprehension (Carver, 1982), although subsequent recall may not be as great as it is for lower levels of speed. A large number of studies show that rates beyond this level cause comprehension to drop off precipitously (Carver, 1982; Sticht, 1968).

For this study, 175 wpm was selected as the speed of the original recording, and defined as "normal" speech. For the compressed speech recording, 262 wpm was chosen. Since this rate approaches the cognitive capacity limit of 280-300, it was believed that it would not push slower students past their personal limits. Higher rates were not chosen because comprehension may have been sacrificed.

Purpose & Hypotheses

The purpose of this research was to determine if systematically designed text augmented with compressed speech could increase the number of objectives achieved and reduce the amount of learning time needed for mastery of the objectives. The effectiveness of learning was defined as the number of objectives mastered. Efficiency was defined as the effectiveness divided by instructional time multiplied by 100. A self-report method was used to reveal the actual instructional time elapsed. This allowed investigation of the actual time the students used to complete the instruction, including rewinding, practice activities, and review.

It was hypothesized that: 1. The text materials augmented with compressed speech audio tapes would be more effective than text alone. 2. The text materials augmented with compressed speech audio tapes would be more efficient (concepts learned per minute) than either text alone or text augmented with normal speech audio tapes.

Method

The methodology was designed to determine the optimal type of audio augmentation for systematically designed text materials. The optimal augmentation was defined as the one that allowed for the highest comprehension and the largest time savings.

Subjects

The participants in this study were 78 students from 5 schools with vocational education programs in the State of Florida. Urban and rural schools were both included. 23 program areas were represented. There were 28 males and 50 females of which 54 were white and 24 non-white. The ages ranged from 16 to 67 years.

The participants had reading levels that ranged from the 3.1 to 12.9 grade level according to their total reading scores on the Test of Adult Basic Education (TABE). The mean reading score was 8.8; the standard deviation was 2.0. Subjects were randomly assigned to the control group and the treatment conditions by placing them in groups in rotating order as they entered into the lab.

Materials

The instructional materials selected were designed for the State of Florida by the Center for Instructional Development and Services, The Florida State University.

> The Employability Skills Series is a set of instructional materials designed to teach secondary students and adults the skills involved in getting and keeping a job. The purpose of the series is to provide educators with ready-to-use student materials that are competency-based and validated for effectiveness and acceptability in actual classrooms. Oriented to young adults but written at a reading level of approximately fifth grade, the materials have a flexible format that can be used in a variety of instructional settings. (Florida, 1979, p. 6)

This series was selected because it was developed using a rigorous instructional design process including formative and summative evaluations and periodic updates (Kromhout, Farrow, Foster, & Morse, 1978). The materials were written at a reading level that would produce efficient and effective learning for the specified population.

The unit Good Work (Florida, 1979) was chosen because it was the most widely and regularly used module. The total instructional package included: 1. A text module from the series covering the introduction, knowledge objectives, and instruction for these objectives. 2. Practice activities corresponding to the text. 3. Audio tapes corresponding to the chosen text.

The text of the written materials was used as a script for the audio tapes, as suggested by other studies (Nasser & McEwen, 1976; Nugent, 1982; Rohwer & Harris, 1975). Only the text portion of the materials were recorded, the practice exercises were not. A male voice was selected to read the text (Foulke & Sticht, 1967). This narrator was a professional radio announcer. Additionally, to enhance quality, the scenarios pictured in cartoons or described in the text were read by a variety of male and female character voices. The recording was made in a professional sound studio.

In order to record the tape at an average speed of 175 wpm the narrator used a script with 175 word segments marked off and used a stop watch to pace the segment to a minute. After the audio tapes were recorded at normal speed, copies were made at the compression speed using a Model H910 Eventide Harmonizer/Pitch Shifter. The same technique was used to pace the compressed speech tape where 262 word segments were marked off and the speech was digitally compressed to complete each segment in one minute. Music and tone signals for page turning were added after the compressed copies were made so that the music would not sound distorted and the tone would not be too brief. Music was used only at the beginning and end of each lesson.

Variables

The first dependent variable was effectiveness defined as the mastery of knowledge objectives as measured by open-ended tests that asked students to list, to identify, and to name. Mastery is defined in the answer keys provided in the instructor's guide of the learning materials. The tests had already been validated during the development of the instructional materials to insure their ability to measure the objectives (Kromhout et al., 1978). A mastery level of 80% was used for field testing the materials, and for the purpose of determining mastery. If the tests had been altered to a multiple choice for ease of scoring, the validity of the tests might have been altered.

The second dependent variable was efficiency defined as effectiveness divided by instructional time multiplied by 100. Instructional time was measured by a self-report method of beginning and ending times for each of the four lessons in the instructional materials. (Mengel, 1982)

The independent variable was the augmentation of the text materials. A control group received only the text materials with no augmentation. One treatment group received the text with a normal speech audio tape of 175 wpm. The other treatment group received a compressed speech audio tape of 262 wpm.

Analysis

The data were analyzed using a one-way analysis of variance for each of the dependent variables, effectiveness (mastery of objectives), and efficiency (effectiveness per unit of time). Three groups were examined: a control group with text only; and two treatment conditions, text with normal speech and text with compressed speech. Reading scores for the Test of Adult Basic Education (TABE) were used as a covariate measure. The alpha level was set at .05 using a two tailed test. A sample of 21 subjects per treatment group (63 total), would generate a power of .80 where the alpha level was .05 and the desired effect size (the minimum difference considered to be of practical importance) was .40 standard deviation, (Cohen, 1977, p. 384). Data were collected from 83 participants in six schools. One school was dropped because protocol was not maintained. The final sample consisted of a control group containing 28 subjects, a normal speech group containing 28 subjects, and a compressed speech group with 22 subjects. The sample totaled 78 subjects.

Procedure

The learning environment. A learning laboratory was used for this study to enhance the ability to examine the augmentation levels by reducing error caused by noise. Students used individual tape recorders with headphones and were allowed to work at their own pace.

The experimental procedure. Before the study was conducted, management packages were produced to ensure consistency in the data collection. The use of the packages was demonstrated in a site visit to each school. An accordion file folder was labeled and organized with management information, student documents, and the audio materials. The file also provided space for forms in progress and completed forms. Supervisory materials were located in a large envelope held in the front of the package. All paperwork was color-coded for ease of handling.

The unit was used in the same manner as other instructional materials in the media center to provide a true picture of how management and setting might impact the use of compressed speech. For example, students were able to choose the amount of the module they would complete at each sitting. The module was divided into four 10-20 minute lessons over the eight objectives to provide convenient stopping places. The students were also able to choose their own schedule for taking the lessons and the post-test. The range was from 10 to 15 days. Through a self-report method, the participants kept track of the actual times spent on each lesson.

The materials contained an introduction and several units of instruction. According to the literature a slight practice listening to compressed speech is enough to acclimate the student to the speed of the tape (Perry, 1970). For this reason, the introduction found in the text materials was used on the audio tapes. The introduction on both normal and compressed speech audio tapes described the purpose of the audio tape and informed the learner that the voice of the speaker may have sounded faster than normal (Williams et al., 1983-84).

Timing started with the first lesson. The subjects were allowed to replay or re-read the introduction as many times as they felt necessary. The students were requested to try to complete all of the instruction in a lesson before taking a break. They were informed that if they needed to stop the instruction for any reason, they were to write down the time they stopped and then restart the instruction. The audio introduction informed the learners that they could rewind the tape if necessary to repeat portions they hadn't understood. This allowed the researcher to investigate the actual timing of the use of the tapes in a media center. If the participants needed to rewind the compressed speech tapes more often, the analysis would show that these rates are not as efficient for learning.

The project monitors retrieved the instructional packages and information sheets from the subjects and gave them the posttests when all the lessons had been completed. The project monitors were asked to make sure that all of the blanks were filled in on both the information form and the tests. The tests were scored using information in the instructor's guide and rechecked later for consistency in scoring.

Results

Two separate one-way analyses of covariance (ANCOVA) were used to test the statistical significance of the hypotheses. Reading scores from the Test of Adult Basic Education (TABE) were used as a covariate measure. Alpha was pre-set at .05 for both analyses. The total n = 78.

First, the internal consistency of the comprehension posttest was evaluated for the sample. There were no comparison statistics from the original field-test since the objective was to create a criterion-referenced measure that worked with 80% of the population. This would have necessarily biased any internal consistency statistics. Since the purpose of this study was to use the information in a norm-referenced context, an internal consistency reliability coefficient, (Cronbach's alpha) was calculated. The comprehension posttest had a reliability coefficient of alpha = .65. This result was considered acceptable due to the original objective of the measurement instrument and the small number of items (n = 8) on the test.

Cochran's C statistic was used to check for homogeneity of variance for both hypotheses. There were no significant differences among the variances of the treatment groups on either dependent variable. There was a significant difference for the time variable used in a post hoc analysis. (Table 1)

TABLE 1

Cochran's C Test
for Homogeneity of Variance

Dependent Variable	Cochran's C	# of Variances	df	Probability
Effectiveness	.431	3	27	.312
Efficiency	.427	3	27	.343
Time	.533	3	27	.020*

*Significant at p<.05.

A test for homogeneity of regression was used to determine whether the TABE scores could be used successfully as a covariate measure. No significant differences were found among the regression line slopes of the covariate on each dependent variable for each treatment group. An ANOVA for reading scores showed no significant differences between the means of the treatment groups.

For a measure of the relationship between the variables and the covariate, Pearson's Product-Moment Correlation Coefficients were calculated. There was a significant correlation between TABE and efficiency, and, TABE and effectiveness. There was a significant correlation also between time and efficiency. (Table 2)

TABLE 2

Pearson's Product-Moment
Correlation Coefficients

	Effectiveness r/p	Efficiency r/p	Time r/p
Reading Scores	.45/.001**	.36/.001**	-.06/.312
Effectiveness	....	.51/.001**	.09/.222
Efficiency	....	....	-.67/.001**

*Significant at p<.001.

Histograms were used to check the assumption of normality. It was clear from the results that the comprehension posttest to measure effectiveness created a ceiling effect in all groups. When examining a histogram of the sample for the efficiency measure, a skewness of 1.2 was found. The tail was toward higher efficiency scores.

It is probable that this tail was created by the ceiling effect of the comprehension posttest which is a component of the efficiency formula. These extreme scores represented subjects who hit the ceiling in a short time and are considered efficient learners. Since their scores were legitimate, they represent a segment of the population. These scores were not deleted.

It was decided that since no other assumptions were violated and considering the robust nature of ANOVA regarding the normality assumption, these scores could still be used. However, since the ceiling effect was pronounced, and could possibly bias the efficiency measure, it was determined that a post-hoc analysis of the time component should be examined as well. The results of this analysis will be given after the two primary analyses.

A one way ANCOVA was then used to test the null hypothesis that all treatment groups would be equivalent with regard to effectiveness. Effectiveness was defined as: the number of correct objectives on a comprehension posttest. The null hypothesis could not be rejected. Table 3 presents the means and standard deviations and Table 4 summarizes the ANCOVA statistics.

TABLE 3

Means and Standard Deviations Of Effectiveness Scores by Treatment Group with Reading Scores as the Covariate Measure

		Effectiveness			
Treatment Group	Covariate Mean	Actual Mean	Adjusted Mean	Standard Deviation	Group Size
Text Only	9.19	6.82	6.70	1.77	28
Normal Speech with Text	9.03	6.89	6.82	1.10	28
Compressed Speech with Text	8.02	6.32	6.59	1.70	22
Total	8.80*	6.71**	6.71	1.54	78

* TABE reading scores ranged from 3.1 to 12.9.
**Total possible score = 8.00.

TABLE 4

Summary of ANCOVA for Effectiveness Scores by Group with Reading Scores as the Covariate Measure

Source of Variation	df	SS	MS	F Ratio	Sign. of F	% of Var.
TABE-Reading Comprehension	1	36.54	36.54	18.66**	.000**	20%
Treatment	2	.66	.33	.17	.845	0%
Residual	74	145.02	1.96	....	....	80%
Total	77	182.22	2.37	....	....	100%

**Significant at p<.001.

Another one way ANCOVA was used to test the null hypothesis that all treatment groups would be equivalent with regard to efficiency. Efficiency was defined as: effectiveness/number of minutes to complete instruction X 100. The null hypothesis was rejected; significant differences among the groups at the p<.05 level were indicated. Means and standard deviations are presented in Table 5, and ANCOVA statistics are summarized in Table 6.

TABLE 5

Means and Standard Deviations
Of Efficiency Scores by Treatment Group
with Reading Scores as the Covariate Measure

Treatment Group	Covariate Mean	Efficiency			Group Size
		Actual Mean	Adjusted Mean	Standard Deviation	
Text Only	9.19	6.95	6.74	3.07	28
Normal Speech with Text	9.03	5.61	5.48	1.82	28
Compressed Speech with Text	8.02	6.99	7.43	3.08	22
Total	8.80*	6.48**	6.48	2.74	78

* TABE reading scores ranged from 3.1 to 12.9.
**Individual Scores ranged from 1.10 to 17.78.

TABLE 6

Summary of ANCOVA
for Efficiency Scores by Group
with Reading Scores as the Covariate Measure

Source of Variation	df	SS	MS	F Ratio	Sign. of F	% of Var.
TABE-Reading Comprehension	1	74.95	74.95	12.22**	.001**	13%
Treatment	2	48.38	24.19	3.94*	.024*	8%
Residual	74	454.03	6.14	......		79%
Total	77	577.36	7.50	......		100%

*Significant at p<.001.
*Significant at p<.05.

In order to determine which pair of groups were significantly different on efficiency scores, post-hoc Tukey pairwise comparisons were made. The results of these pairwise comparisons are presented in Table 7.

TABLE 7

Post-Hoc Pair-Comparisons for Efficiency Scores by Group with Reading Scores as the Covariate Measure

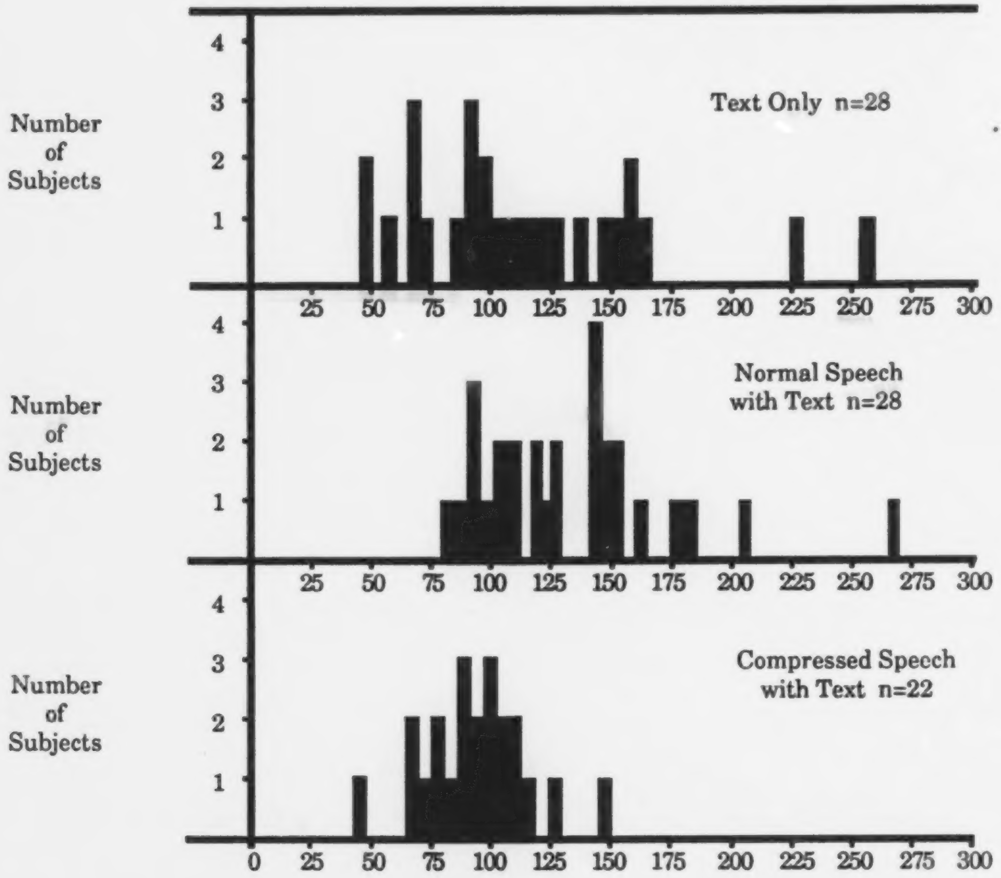
	Text Only t/prob.	Normal Speech with Text t/prob.
Normal Speech with Text	-1.90/.06	....
Compressed Speech with Text	.95/.34	2.71/.009*

*Significant at p<.01.

Another post-hoc analysis was used to examine the Time element of the efficiency formula because of the ceiling effect apparent in the effectiveness portion of the formula. Time was defined as: the number of minutes to complete instruction. Since the Cochran's C showed significant differences among the variances of the treatment groups (Table 1), the individual scores were placed on a graph for further examination. (See Figure 1 for the graph.)

FIGURE 1

Graph of Individual Scores
of Time to Complete Instruction
Using Five Minutes Intervals



An ANCOVA was used although the assumption of homogeneity of variance was violated. It was determined that the loss of power due to this violation was at an acceptable level. The ANCOVA demonstrated significant differences at the $p < .05$ level. See Table 8 for means and standard deviations and Table 9 for ANCOVA statistics.

TABLE 8

Means and Standard Deviations Of Time Scores by Treatment Group with Reading Scores as the Covariate Measure

Treatment Group	Covariate Mean	Time			
		Actual Mean	Adjusted Mean	Standard Deviation	Group Size
Text Only	9.19	112.50	113.54	49.45	28
Normal Speech with Text	9.03	133.36	133.98	41.23	28
Compressed Speech with Text	8.02	96.18	94.05	21.07	22
Total	8.80*	115.38**	115.38	42.43	78

* TABE reading scores ranged from 3.1 to 12.9.
**Individual Scores ranged from 45.00 to 268.00.

TABLE 9

Summary of ANCOVA for Time Scores by Group with Reading Scores as the Covariate Measure

Source of Variation	df	SS	MS	F Ratio	Sign. of F	% of Var.
TABE-Reading Comprehension	1	442.42	442.42	.28	.602	0%
Treatment	2	19,077.62	9,538.81	5.93*	.004*	14%
Residual	74	119,120.43	1,609.74	....	....	86%
Total	77	138,640.46	1,800.53	....	....	100%

*Significant at $p<.01$.

In order to find out which pair of groups were significantly different, post-hoc Tukey pairwise comparisons were made. The results of these pairwise comparisons are presented in Table 10. To gain a complete picture of time savings, time elements for treatment groups were compared. (See Table 11.)

TABLE 10

Post-Hoc Pair-Comparisons
for Time Scores by Group
with Reading Scores as the Covariate Measure

	Text Only t/prob.	Normal Speech with Text t/prob.
Normal Speech with Text	-1.91/.06	....
Compressed Speech with Text	-1.66/.10	3.42/.001*

*Significant at $p<.001$.

TABLE 11

Comparison of Time Savings
in Minutes by Treatment Group

Treatment Group	Total Time*	Lesson Only**	Rewind Activ.***	Additional Time****
Text Only	113.54	....	....	21%
Normal Speech with Text	133.98	66.07	67.91	42%
Compressed Speech with Text	94.05	44.05	50.00	0%

* Total time = Adjusted means for each group.
** Lesson only + The exact audio tape lengths.
*** The rewind/activities + Total time - Lesson Only.
**** Additional Time = Total time/Compressed Speech Total Time (the shortest total time).

Discussion

The statistical results of the study showed systematically designed text to be a highly effective form of learning. Since all groups reached a ceiling effect with regard to the mastery of the objectives, augmentation made no difference with regard to the effectiveness of the materials.

Another finding of the study was that the overall variance in the amount of time used for the lesson was reduced by the use of compressed speech. The text only group had the largest variance. This might be expected since the participants paced themselves by their individual reading rates. The normal speech with text group had less variance that could be a result of the mechanical pacing of the tape, but the variance was still quite large.

Based on cognitive theory, these large variances could be due to some participants of the text only and normal speech groups having to repeat portions of the instruction because of their inability to maintain attention at the slower rate of information flow. The compressed speech with text group had the smallest variance. (See the graph in Table 8.) If the theory is correct, this compact variance may be due to the participants' ability to maintain their attention on the instruction using compressed speech augmentation. The difference in variances could, however, simply be due to the total instructional time. Since compressed speech shortens the instructional time, there could be less fatigue occurring in this treatment group. This raises a question for future research regarding the actual cause of the reduction of variance.

The post-hoc analysis examining only the time feature of the study showed considerable instructional time savings. The time data included time to rewind when necessary and to complete activities interspersed throughout the lessons; therefore, the time savings would not compare to studies that evaluate time savings using word rates. For example, 262 wpm (compressed speech) is 1.5 times or 50% faster than 175 wpm (normal speech) (Foulke & Sticht, 1967; LaBarbera & MacLachlan, 1979; Sticht, 1971.) However, the percentages found in this study should give a more accurate picture of the time savings that could be expected when compressed speech tapes are used with a full complement of text and practice activities. See Table 11 for a comparison of time savings.

In a media center, or in a classroom, the small variation between students and instructional time savings could be a distinct advantage. Activities could be planned around more predictable beginning and ending times for all students. Since systematically designed text alone is already highly effective and efficient for most students, a cost-benefit analysis should be used to determine if the decreased variance and time savings is worth the additional expense of producing the compressed speech tape.

With regard to the choice of augmentation, the statistical results of the study did, however, indicate support for the hypothesis that with systematically designed instruction the text materials augmented with compressed speech audio tapes are more efficient (concepts learned per minute) than text augmented with normal speech audio tapes; however, they are equally as efficient as text alone.

It is not enough to assume that because the overall effectiveness of compressed speech was equivalent to normal speech and the word rate was faster, the result is greater efficiency. The results of this study were calculated using an individualized efficiency formula to examine the efficiency for each individual participant. In addition, this study was designed to investigate the actual time used to complete the instruction, rather than, the word rate or tape length alone. The result was, that even with the ability to rewind the tape and listen to the instruction again, the text augmented with compressed speech is still more efficient than the text augmented with normal speech and equal to the text alone. If augmentation were used with systematically designed text, compressed speech would be the better choice.

As in many studies (Foulke, 1967; Orr, 1968; Sticht & Friedman, 1964; Woodcock & Clark, 1969), the hypothesis regarding the effectiveness of compressed speech did not show any significant increase over the other treatment. It does, however, demonstrate that systematically designed materials can be successfully compressed without any significant loss in comprehension. The combination of compressed speech and terse text does not apparently overcompress the information flow.

Successful comprehension in combination with the other findings regarding efficiency, time savings, and reduced variability, demonstrate that the use of compressed speech tapes to augment systematically designed instruction may be a valuable addition to the instruction process when a cost-benefit is determined.

Limitations of the Study

A limitation of this study and other studies using systematically designed materials is creating a "ceiling effect" when examining comprehension. In the process of development, the instructional materials are revised until they are highly effective. The variance in performance, in effect, has been engineered out of the materials, and one might expect little variance in effectiveness among treatment groups. However, other variables of interest, such as, time and efficiency (as defined in this study) require that effectiveness be measured, even if it is a constant.

Suggestions for Further Research

A question was raised in this research as to whether compressed speech with text indeed reduces the variability of the amount of time needed to complete the instruction, or does the length of time spent on the instruction impact on the variability. Is the variability caused by unfilled cognitive capacity or by fatigue? By using systematically designed materials to exaggerate the ceiling effect, comprehension could be controlled. In this way, the instruction could be lengthened so that instructional time could be allowed to vary, thereby measuring time to mastery as the dependent variable.

The cognitive theory in this study has set forth an idea that rauding rate (Carver, 1982) and cognitive capacity are related. To fully examine this idea, future studies could employ a reaction time (RT) method (Johnson & Heinz, 1978) to find out how much cognitive capacity is being used when people are reading or listening at the rauding rate. The study could be designed much the same as this one using the text only, normal speech with text and compressed speech with text group. Added would be a reaction time task, such as, a light that would randomly turn on during the instruction. The length of the reaction time that it would take the participants to push a button indicating that they saw the light should indicate which group was using the most cognitive capacity.

As the technology for compressed speech improves to the point where there is no distortion for higher levels of compression, another important study will be to investigate the effect of practice on the comprehension of faster and faster levels of compressed speech. This research may provide clues as to the limits on the rate of flow the brain can accommodate.

Further research needs to include larger scale studies using classroom situation since most instruction is currently delivered in this manner. Most studies of this type have used adults in military or university settings. Researchers should consider using younger participants in subject areas that have a high degree of difficulty, such as science.

This study showed a large variance in the instructional time for the text only group. It appears that compressed speech may reduce that variance for the slow readers. Also, the question as to whether compressed speech can increase comprehension for slow readers is of interest. A study is needed that examines compressed speech augmentation with instructional materials that the population has more difficulty in comprehending. In addition to a reading level score, a measure of the participants' habitual reading rate should be calculated to use as a covariate measure. The correlation between participants' reading level and reading rate should be explored. Results of this type of study would determine whether it would be worthwhile to augment traditional school texts that are written above the capability of the low level reading population.

Another study might examine whether using compressed speech with text may help slow readers learn a new cognitive strategy for reading. A base-line reading rate and comprehension level should be tested at the beginning of the study. A control group would use the text only throughout the study. The treatment group would be given compressed speech with text. After each increment of the study reading rate and comprehension would be tested on a reading only task. The study may be able to show if a new cognitive strategy for reading can be learned and how many practice sessions with compressed speech could effect a change.

References

Apple, W., Streeter, L. A., & Krauss, R. M. (1979). Effects of pitch and speech rate on personal attributions. Journal of Personality and Social Psychology, 37, 715-727.

Berlyne, D. E. (1960). Conflict, arousal and curiosity. New York: McGraw-Hill.

Boyle, V. A. (1969). Visual stimulation and comprehension of compressed speech (Doctoral dissertation, George Peabody College for Teachers). Dissertation Abstracts International, 30, 5221B.

Bradtmueller, W. G. (1978, October). Speed listening and reading. Paper presented at the Annual Meeting of the Great Lakes Regional Conference of the International Reading Association, 3rd, Cincinnati, OH. (ERIC Document Reproduction Service No. ED 167 953)

Carver, R. P. (1981). Reading comprehension and rauding theory. Springfield, IL: Charles C. Thomas.

Carver, R. P. (1982). Optimal rate of reading prose. Reading Research Quarterly, 18(1), 56-88.

Cohen, J. (1977). Statistical power analyses for the behavioral sciences (2nd ed.). New York: John Wiley.

Florida Department of Education. (1979). The Employability Skills Series. Tallahassee, FL: Author.

Foulke, E. (Ed.). (1966). Proceedings of the Louisville conference on time-compressed speech. Louisville, Kentucky: The Center for Rate Controlled Recordings.

Foulke, E. (1967). Time compressed recorded speech and faster aural reading. Blindness AAWB Annual, 11-20.

Foulke, E., & Sticht, T. G. (1967). The intelligibility and comprehension of time-compressed speech. In E. Foulke (Ed.) Proceedings of the Louisville conference on time-compressed speech (pp. 21-28). Louisville, KY: University of Louisville.

Gagne, R. M. (1985). The conditions of learning (4th ed.). New York: Holt, Rinehart and Winston.

Hsia, H. J. (1968). Output, error, equivocation, and recalled information in auditory, visual, and audiovisual information processing with constraint and noise. The Journal of Communication, 18, 325-353.

Johnston, W. A., & Heinz, S. P. (1978). Flexibility and capacity demands of attention. Journal of Experimental Psychology: General, 197, 420-435.

Kromhout, O. M., Farrow, D. R., Foster, B. F., & Morse, L. W. (1978, March). The systematic design, and evaluation of competency-based instructional materials for employability skills. Paper presented at the annual meeting of the American Educational Research Association, Toronto, Ontario.

LaBarbera, P., & MacLachlan, J. (1979). Time-compressed speech in radio advertising. Journal of Marketing, 43, 30-36.

Lass, N. J., Foulke, E., Nester, A. A., Comerci, J. (1974). The effect of exposure to time-compressed speech on subjects' listening rate preferences and listening comprehension skills. The Journal of Auditory Research, 3, 179-186.

Mengel, N. (1982). The acceptability and effectiveness of materials revised using instructional design criteria. Unpublished doctoral dissertation, Florida State University.

Miller, N., Maruyama, G., Beaber, R. J., & Valone, K. (1976). Speed of speech and persuasion. Journal of Personality and Social Psychology, 34, 615-624.

Nasser, D. L., & McEwen, W. J. (1976). The impact of alternative media channels: Recall and involvement with messages. Audio Visual Communication Review, 24, 263-272.

Nugent, G. C (1982). Pictures, audio, and print: Symbolic representation and effect on learning. Educational Communications and Technology Journal, 30, 163-174.

Olson, J. S. (1985, January). Study of the relative effectiveness of verbal and visual augmentation of rate-modified speech in the presentation of technical material. A paper presented at the national convention Association for Educational Communications and Technology, Research and Theory Division, Anaheim, California.

Orr, D. B. (1966, May). Retention in educable mentally retarded children of material presented by simultaneous reading and listening. Paper presented at the meeting of the International Reading Association, Seattle.

Orr, D. B., Friedman, H. L., & Graae, C. N. (1969). Self-pacing behavior in the use of time-compressed speech. Journal of Educational Psychology, 60(1), 28-31.

Perry, T. K. (1970). The effects upon the learner of a compressed slide-audio tape presentation experienced in a learning carrel as measured by recall and application tests. (Doctoral dissertation, Michigan State University). Dissertation Abstracts International, 31, 4019A.

Rohwer, W. E., & Harris, W. J. (1975). Media effects on prose learning in two populations of children. Journal of Educational Psychology, 67, 651-657.

Sticht, T. G. (1968). Some relationships of mental aptitude, reading ability, and listening ability using normal and time-compressed speech. The Journal of Communication, 18, 243-258.

Sticht, T. G. (1971). Failure to increase learning using the time saved by the time compression of speech. Journal of Educational Psychology, 62(1), 55-59.

Taylor, Stanford E. (1965). Eye Movements in Reading: Facts and Fallacies. American Educational Research Journal, 2, 187-202.

Williams, D. L., Moore, D. M., & Sewell, E. H., Jr. (1983-1984). Effects of compressed speech on comprehension of community college students. Journal of Educational Technology Systems, 12, 273-284.

Woodcock, R. W., & Clark, C. R. (1969). Comprehension of a narrative passage by elementary school children as a function of listening rate, retention period, and I. Q. The Journal of Communication, 18, 259-271.

Title:

Thirty Teaching Strategies Used by Teachers of At-Risk Students

Authors:

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Thirty Teaching Strategies Used by Teachers of At-Risk Students

In 1989-90 Phi Delta Kappa conducted a national survey in approximately 100 communities in North America which involved 100 schools at each of the elementary, junior high, and high school levels. The data collected from the teacher survey was analyzed at Indiana State University by the authors. Approximately 9,259 teachers(2,078 elementary, 2,822 junior high, and 4,359 senior high school) reported strategies they regularly used with at-risk students. In addition the instrument collected information necessary to develop a profile of the typical teacher described as white, female, forty-one years of age, and holding a bachelor's degree. The average length of teaching experience reported by teachers was sixteen years, with six-and-a-half years at their current school.

Data Analysis

Data analysis concerning teachers' responses to thirty teaching strategies revealed whether teachers used each strategy and how effective they felt each strategy was with at-risk students. Teachers responded "yes" or "no" to whether they used the 30 strategies listed and rated the effectiveness of each strategy on a four-point scale from "not very effective" to very effective. The effectiveness column reflects the combining of "very effective" and "effective" categories.

A rank ordering based on teachers' "yes" responses to their use of each strategy is provided for elementary teachers in Table 1, junior high teachers in Table 2, and senior high school teachers in Table 3. The responses for each school level were further divided into four groups according to the rankings on the basis of "yes" responses of 75 percent or more, 50 to 74 percent, 25 to 49 percent, and 24 percent or less. As can be seen in tables 1, 2, and 3 eight strategies at the elementary level received a 75 percent or higher use while five strategies received this level of response in the junior high and senior high schools.

Tables 1, 2, and 3
About here

Particularly noteworthy is that two response categories at all three school levels reflect 92 percent or above use: (a) notify parents and (b) confer with parents. These two categories ranked either one or two at all three school levels. The rated effectivenesss of these two categories, however, did not place them in the top ten strategies for the elementary teachers, and in places 10 for junior high and 9 for senior high. Elementary teachers may have responded less than the other two groups of teachers because of mandatory parent conferences for many elementary schools.

The top three strategies in terms of effectiveness at the elementary school level were individualizing instruction(95 percent), special teachers(92 percent), and more time on basic skills(91 percent). The strategies most effective at the junior high school were individualized instruction(89 percent), smaller classes(86 percent), and more time on basic skills(85 percent). At the senior high school level individualized instruction(90 percent), smaller classes(86 percent), and vocational courses(85 percent) were the top strategies in effectiveness.

Use of more time on the basic skills was reported at the three school levels(elementary 91 percent, junior high 82 percent, and senior high 82 percent) which supports the results of the interest generated in the media and from testing which helped to establish the need for more basic skills developement and performance among school children. Citizens generally feel that without improvement in the basic skills students are going nowhere in the academic arena or in the workforce. Furthermore being a productive citizen is tied to the acquirement of the basic skills.

In addition to the top three ranked strategies at the elementary level, five other strategies deserve attention such as emphasized thinking skills, and individualized instruction. Ranking elementary teachers' judgment of the top ten strategies in effectiveness provides the following list:

Individualized instruction(94 percent)
Special teachers(92 percent)
More time on basic skills(91 percent)
Smaller classes(89 percent)
Emphasize thinking skills(89 percent)
Special education(88 percent)
Special study skills(87 percent)
Emphasize coping skills(87 percent)
Teacher aides(85 percent)
Peer tutoring(84 percent)

At the junior high school, in addition to the five top strategies used, a list of the the top ten strategies based on judged effectiveness is as follows:

Individualized instruction(89 percent)
Smaller classes(86 percent)
More time on basic skills (85 percent)
Special education(85 percent)
Special teachers(85 percent)
Special study skills(83 percent)
Emphasize coping skills(82 percent)
Emphasize thinking skills(82 percent)
Vocational courses(80 percent)
Confer with parents(79 percent)

At the senior high school, in addition to the five top strategies used, a list of the top ten strategies based on judged effectiveness is:

Individualized instruction(90 percent)
Smaller classes(86 percent)
Vocational courses(86 percent)

More time on basic skills(85 percent)
Special education(82 percent)
Emphasize thinking skills(82 percent)
Special study skills(81 percent0
Special teachers(81 percent)
Confer with parents(81 percent)
Emphasize coping skills (81 percent)

It is interesting, in regard to teachers judgment concerning the effectiveness of strategies, that at all three school levels individualized instruction was at the top. Smaller classes was second at two levels and third at another. Several strategies occur on the top ten effective lists for the three levels such as emphasize thinking skills, emphasize coping skills, and special teachers. Keep in mind that educators have the option to use one or more of the strategies concurrently. Therefore, infomation from teachers concerning the clustering of these strategies is important because it probably suggests that they are using several of these strategies concurrently on a regular basis.

In general, the elementary teachers' percent ratings were higher than the junior or senior high teachers. This was especially true in the ratings involving effectiveness. Apparently, although not supported by hard data, the at-risk student at the elementary level is not so pronouncedly different from peers within the school. At the junior and senior high school the at-risk students become more segregated or recognized and their problems become more obvious and pronounced which creates more frustration for the teacher and in turn less positive responses from teachers.

If the ten most effective categories are reported, then the reader might also appreciate the reporting of the six categories for each school level judged least effective. The elementary teachers reported the following six least effective strategies:

Computerized instruction (56 percent)
Before school programs (46 percent)

Extra homework (30 percent)
Restrict from sports (26 percent)
Eliminate art and music (9 percent)
Say "leave at age 16" (5 percent)

The junior high teachers reported the following six least effective strategies:

Before school programs (48 percent)
Restrict from sports (42 percent)
Retain in grade (42 percent)
Extra homework (21 percent)
Say "leave at age 16" (15 percent)
Eliminate art and music (9 percent)

Finally, the senior high teachers reported the following six least effective strategies:

Computerized instruction (46 percent)
Retain in grade (46 percent)
Restrict from sports (41 percent)

Extra homework (27 percent)
Say "leave at age 16" (19 percent)
Eliminate art and music (9 percent)

To the credit of all teachers, the top and the bottom effectiveness rankings of strategies are very similar in nature, with the exception of some unique teaching level differences such as "vocational courses." "Vocational courses" rank in the bottom six of the elementary strategies and the top ten of senior high. It could be argued, however, that there are more similarities than differences at all three levels of school regarding perceived use and effectiveness of strategies.

Educators and computer salespersons who make predictions regarding computer education in the year 2000 might focus their attention on how "computer instruction" faired at the three school levels. Notice that the computer strategy made two of the least effective strategies lists. It is interesting to note that most professors who are predictiong the impact of computers in the twenty-first century only use a computer as a word processor in their office.

Attention should be given to any strategies that have low use by teachers and yet judged to have high effectiveness. Only two such strategies met these conditions and those were "restrict from sports" and "home tutoring". Home tutoring was veiwed as effective but was reported as low utilization. Many factors could account for the disparity in reporting use and effectiveness, but most likely would be that there are not sufficient funds to afford more home tutoring. The other strategy in question, "restrict from sports," arose only in the senior high level responses. Forty one percent of the senior high teachers felt that restricting from sports was effective, even though only four percent reported using the strategy. Sports are deemed very important by the administration and the community by senior high. Since the questionnaire to collect the data from teachers used a closed response, there is no data to suggest the thinking processes that accompanied the responses by the teachers.

It would take many more pages to cover all of the data and the subtle nuances that accompany the thirty strategies listed in this questionnaire. While the list does not exhaust all posssible strategies, it does offer some of the more common and more popular strategies now being employed by teachers. The reader can return to the tables and surely glean even more information of interest, and at the same time think of other strategies that should have been included. And ultimately, from this list, future researchers can add to or amend the strategies for more in-depth study of the concepts.

Table 1

Elementary School Teachers Responses to Effectiveness Ranked by Use With Reported Effectiveness

Percent Use	Strategies	Percent Effective
	75 percent or more	
97.7	Confer with parents	83.0
97.6	Notify parents	82.4
91.6	More time on basic skills	91.0
90.2	Emphasize thinking skills	88.6
89.2	Individualize instruction	94.4
87.2	Special teacher	92.0
78.8	Special education	88.3
75.2	Emphasize coping skills	86.8
	50 - 74 percent	
74.7	Flexible scheduling	83.4
73.1	Special study skills	87.1
70.5	Place in low group	66.4
69.2	Peer tutoring	83.7
68.8	Chapter I programs	83.1
67.9	Refer to psychologist	75.5
60.5	Teacher aids	85.0
56.7	Refer to social worker	70.7
56.5	Smaller classes	89.4
56.3	Summer school programs	73.7
	25 - 49 percent	
49.8	Special textbooks	72.3
46.6	Retain in grade	59.6
34.8	Computerized classes	56.5
28.8	After school programs	59.4
26.4	Home tutoring	68.9
25.6	Extra homework	30.3
	Less than 25 person	
21.3	Alternative school	65.3
18.8	Vocational courses	66.5
16.7	Before school programs	46.0
14.3	Restrict from sports	26.8
5.2	Eliminate art and music	9.5
3.3	Say "leave at age 16"	5.7

Table 2
Junior High School Teachers Response to Effectiveness
Ranked by Use With Reported Effectiveness

Percent Use	Strategies	Percent Effective
	75 percent or more	
95.6	Notify parents	77.3
95.5	Confer with parents	79.0
83.9	Emphasize thinking skills	81.6
82.0	More time on basic skills	85.3
77.1	Special education	85.3
	50 - 74 percent	
74.6	Individualize instruction	89.1
69.5	Special study skills	83.4
68.6	Special teachers	85.0
64.9	Emphasize coping skills	82.2
60.0	Peer tutoring	78.4
63.8	Refer to psychologist	71.9
57.1	Refer to social worker	71.1
56.1	Summer school programs	66.5
55.0	Place in low group	55.5
	25 - 49 present	
47.9	Chapter I program	66.6
47.8	After school programs	65.0
47.6	Smaller classes	85.5
47.1	Special books	71.0
45.8	Vocational courses	79.7
44.5	Teacher aids	77.4
44.0	Retain in grade	42.1
43.4	Flexible scheduling	68.7
39.8	Alternative schools	70.3
39.1	Restrict from sports	42.3
25.1	Before school programs	48.3
	Less than 25 percent	
21.8	Home tutoring	60.1
21.2	Computerized instruction	49.6
18.6	Extra homework	21.0
10.3	Say "leave at 16"	15.3
5.5	Eliminate art and music	9.4

Table 3
Senior High School Teachers Responses to Effectiveness Ranked by Use With Reported Effectiveness

Percent Use	Strategies	Percent Effective
	75 percent or more	
93.9	Notify parents	78.7
92.3	Confer with parents	81.3
84.9	Emphasize thinking skills	81.6
82.2	More time on basic skills	85.3
76.8	Individualize instruction	90.0
	50 - 74 percent	
67.7	Special education	82.1
66.6	Vocational courses	85.7
66.2	Special study skills	81.4
66.0	Emphasize coping skills	81.1
62.1	Peer tutoring	80.5
55.9	Summer school programs	71.7
55.8	Special teachers	81.3
54.5	Refer to psychologist	68.6
51.4	Refer to social worker	69.0
	25 - 49 percent	
48.2	Special textbooks	70.4
47.7	Place in low group	50.1
46.3	Smaller classes	86.4
44.1	After school programs	62.4
43.5	Teacher aids	73.8
43.4	Alternative school	70.2
43.3	Retain in grade	46.9
39.9	Chapter I program	59.2
39.0	Flexible scheduling	62.1
25.5	Before school programs	47.1
	Less than 25 percent	
24.8	Home tutoring	61.1
18.9	Computerized instruction	46.8
24.0	Extra homework	27.5
13.1	Say "leave at age 16"	19.7
6.5	Eliminate art and music	9.3
4.7	Restrict from sports	41.5

Title:

Viewing Hypermedia Through the Prism of Evaluation

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Viewing Hypermedia Through the Prism of Evaluation

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Introduction

Hypertext, a vision conceived in the interest of information management (Bush, 1945), has had an influential effect on the "look and feel" of computer interfaces, creating a fusion of once isolated applications and information sources. Hypertext (or more generally hypermedia when encompassing video, sound, and graphics as well as text) not only supports the organization and management of information, but also facilitates the presentation and exploration of information. It is the latter capability that has stimulated considerable debate among educators concerned with the theory and practice of technology-based instruction. The user-centered experiential nature of hypermedia technology makes it a likely vehicle for delivery of instruction (Allison & Hammond, 1990). Unfortunately, the development of hypermedia-based instructional delivery systems is hampered by a scarcity of research which can be used to guide practice and with problems associated with the open-ended design.

Evaluation of technology-based instructional programs often provides insightful investigation of an innovation concerning salient features of the technology and how the features interact in an applied setting. However, evaluation research is inherently problematic due to competing interests of organizations and individuals involved in the process; these problems are not discussed in this paper (see Rossi & Freeman, 1989; Reeves, 1991). Instead, the purpose of this paper is twofold: we seek to establish evaluation as an important concern in hypermedia research and development, and to present a review of current hypermedia evaluation research with a prescriptive focus. Characteristics of hypermedia currently attracting the attention of instructional developers will be discussed. Unfortunately when the attributes of hypermedia are brought into focus by recent evaluation research, findings are often limited; conclusions drawn from these developments will be presented, along with distinguishing features that separate the evaluation approaches employed. Characteristics of hypermedia which present challenges to evaluative studies will be analyzed and possible methodological solutions will be raised. Finally, we will describe current and proposed activities at Lehigh which seek to apply the ideas presented in this paper to the development of hypermedia applications for technology transfer and training in engineering and other areas.

Hypermedia and Computer-Assisted Learning

The interface can be thought of as the first gateway to effective instructional delivery in a computer-assisted learning (CAL) system. In contrast to earlier behavioristic models which required the learner to respond in a specific manner and measured observed behavior (Skinner, 1986), more recent delivery systems influenced by a cognitive approach attempt to provide learning experiences for the learner so that the learner may elaborate, modify and integrate the material presented with previous knowledge. The experiential nature of hypermedia meshes with the exploratory and generative learning orientation of cognitive theory. Consequently hypermedia is becoming an attractive choice for some CAL developers (Allison & Hammond, 1990). However, the open environment of hypermedia presents new challenges in designing and evaluating applications specifically to achieve learning goals.

The principal problem related to using hypermedia as a delivery mechanism for instruction, as identified by Hammond (1989), concerns the learner's experience exploring the information. Exposure to large bodies of unfamiliar information may not be suitable for all tasks or all individuals and may result in confusion or indecisiveness on the part of the learner. Developing an overview of the material and the way it is organized can be difficult for the learner; sometimes merely locating information that the individual knows is included in the application can be a problem. Connecting the information in a myriad of ways may create uncertainty for learners, who may become hesitant to make a selection because they are unsure of what to expect or of what is expected of them. Cognitive resources expended in attempting to master the hypermedia interface may interfere with the intended learning task.

Characteristics of Hypermedia Applications Designed for Learning

Currently there are no universal standards governing what hypermedia (or hypertext) entails, although efforts in this direction are being formulated (Moline, Benigni, & Baronas, 1990). The instructional developer must depend on experience and intuition to design and develop an application incorporating features of hypermedia or hypertext. Therefore, characteristics of hypermedia for learning as identified in literature on the use of hypermedia in learning environments will be explored as potential variables of evaluation studies.

Gagné and Briggs (1979) identify four classes of variables that have the potential to influence an evaluation study: process variables, outcome variables, support variables, and aptitude variables. Process variables refer to factors in an instructional situation which have the potential to influence outcome. Outcome variables refer to measured variables; the focus of the study. Support variables are represented as "opportunities for learning" (p. 297); for example, the presence of adequate materials and climate represent such variables. Aptitude variables represent the learner's ability in an educational situation.

Process variables include: instructional sequence, pacing, and events of instruction (Gagné & Briggs, 1979). Romiszowski (1990) suggests the focus of hypermedia literature emphasizes the benefits of hypermedia for learning (e.g. non-linear access, learner-controlled, distributed organization) resulting in a "process oriented philosophy" (p. 322). Viewing hypermedia in a process oriented context, as characterized in the literature, separates each characteristic from the expected outcome or goal anticipated by using hypermedia for learning.

The products of learning, or outcome variables, are often characterized in cognitive terms in the literature describing the benefits of hypermedia. For example, Kozma (1991) suggests that knowledge representation may exist along multiple instead of single conceptual dimensions. He also suggests that complex situations generate an assembly of representations instead of retrieving an intact schema; hypermedia may facilitate this representation. However, traditional tests are not designed to provide such cognitive assessments.

Attributes which emphasize the benefit of using hypermedia for learning as characterized in literature are identified in Table 1 as primary process characteristics. Each primary process characteristic (i.e., independent of other characteristics) is presented with an associated product characteristic. Secondary characteristics are not identified in this table and include those factors that are influenced by and have the potential to influence additional characteristics. An example of a secondary characteristic is self-regulation; Kinzie and Berdel (1990) suggest self-regulation is facilitated by learner control. To elucidate this distinction, an example representing the relationship between learner-control and self-regulation as discussed in Kinzie and Berdel is represented in Figure 2. Although Kinzie and Berdel suggest hypermedia may facilitate self-regulation, it is mediated through learner control and therefore does not appear as a characteristic in Table 1. A perspective of these characteristics is available through the filter evaluation provides.

Recent Developments in Evaluation Research on Hypermedia

Hypermedia, as it pertains to instructional systems technology, incorporates many aspects associated with computer-based instruction (CBI). Research conducted on factors such as color, screen arrangement, video, and learner control, are applicable to hypermedia design. Evaluation of hypermedia applications becomes more problematic than directed CBI because the major characteristic of hypermedia, the ability for the learner to traverse the application in a multitude of ways, makes each learner's experience unique. Browsing and navigation, inherent in hypermedia, decrease the ability to control the experimental condition.

Our objective is not to present a review of all hypermedia and hypermedia-related evaluative research. Instead, we wish to concentrate on studies of hypermedia evaluative research used in educational settings. A second criterion, educational applications as opposed to training applications, further narrowed the literature selection process. Table 2, and 2a summarize the following information for each of the eleven articles (consisting of 15 studies) identified by the criteria: evaluation approach used, focus of the study, indication pertaining to support of research hypothesis, instructional content, subjects, and an indication representing the number of treatments.

Conclusions Drawn from Evaluation Research on Hypermedia

Results from hypermedia evaluation studies, identified by selection criteria, are consolidated into five conclusions. Each conclusion is accompanied with an associated cautionary note. Conclusions and cautionary notes are discussed below.

Conclusion 1. Hypermedia study guides can be successfully used as a supplement to and substitute for lecture instruction (Higgins & Boone, 1990; Horton, Boone, & Lovitt, 1990). The consistent delivery inherent in computerized instruction, offers remediation for students needing additional instruction to master subject content, or assistance to students that have missed a lesson. Learner-initiated control of content through a hypermedia interface provides self-pacing, which may be particularly helpful for learning disabled students. A range of instructional cues (in the form of directed assistance) depending on responses to multiple-choice questions, match instructional remediation level with learner's highest level of independent comprehension.

Caution 1. Objective outcome measurements used in comparative studies (Higgins & Boone, 1990), require instructional overlap between the computer-assisted content and supplementary lesson materials such as textbook or teacher initiated lecture. Scarcity of commercially available software or resources necessary for development of quality instruction which match specific content needs of the instructor are prohibitive factors. Measured gain for each learner may differ depending on: learner educational ability, relationships between various screens, and granularity of the nodes in the hypermedia instruction (cf. Lanza & Roselli, 1991; Tripp & Roby, 1990).

Conclusion 2. Learning performance skills (e.g. problem solving, management practices, group interaction) which require a vast range of experiences can be mediated through episodes of peer modeling using video illustrations (Goldman & Barron, 1990). Lesson planning time for the instructor is easier when supplementary materials exist on videodisc.

Caution 2. Development and equipment costs for hypermedia may far exceed costs of traditional instructional methods. A "bottleneck," from new instructional remedy to technological-based teaching tool, may discourage experimenting with new solutions to problems. Although student performance skills increased, students were apprehensive about preparing for traditional examinations after hypermedia instruction was substituted for the lecture (Goldman & Barron, 1990). Students may feel more confident about the importance of information when it is traditionally delivered.

Conclusion 3. Evaluation of hypermedia enhancements during the development cycle has the potential to identify deficiencies of the product, or foster new ideas to improve learner strategies during the development stage (Egan et al., 1989; Covey, 1990). Computer-based monitoring of the frequency with which the learner uses available strategies and of learner task success rates provide a rich source of information to guide subsequent development. Affective measures obtained early in the development process may eliminate costly ineffective options (e.g. such as digital audio feedback, touch screens, etc.) based on learner reactions to pilot versions.

Caution 3. Altering more than one function in an instructional application between formative evaluations may confound the ability to identify the source of improvement. Studies of this nature require a homogeneous pool of subjects. Although subjects may be comparable with respect to many demographic variables, groups of subjects may differ in aspects not compared (e.g. computer experience, motivation, anxiety, history).

Conclusion 4. Metaphors provide a meaningful way to integrate a wide range of information connected by theme (Gay, Trumbull, & Mazur, 1991). The learner is able to utilize the information in an intuitive way.

Caution 4. Post treatment interviews can provide insightful affective indicators pertaining to techniques used in the application, but matching other characteristics of the learner with comments that arise during the interview (e.g. prior knowledge of the subject matter, ability to direct learning, and problem solving skills) makes generalization difficult. The use of metaphor has not been successful in all systems (Tripp & Roby, 1990). When combining metaphors and graphical browsers (or using browsers alone, Mays, Kibby, & Watson, 1988), elements may compete for learners' attention.

Conclusion 5. Relating a series of phenomena encourages interrelational thinking (Landow, 1989). As demonstrated through class discussions and examinations, students contributed a greater range of information than previous classes. Examination responses were judged to be more intellectually sophisticated and more rigorous than responses from previous classes. Students appeared more motivated to contribute their ideas of inter-connectivity, and were perhaps more apt to complete assigned readings because they felt all assignments were interrelated.

Caution 5. Longitudinal studies may indicate novelty or duration limitations. Implementing a study which evaluates performance over a period of treatments may provide evidence that performance using hypermedia increases over time (Higgins & Boone, 1990). Direct transfer of hypermedia experience to course content may occur more frequently when content included in hypermedia instruction is contributed based on the recommendations of the instructor. Conceptual arrangement of the hypermedia, selected by the instructor or designer, may have an effect on learner's ability to make connections. Giving learners the ability to create their own links may influence positive reaction to hypermedia. As *Caution 1* mentioned, developmental costs and instructor's expertise may limit direct transfer of any computer-based instruction to course content.

These conclusions, as shown in Table 2, Table 2a, encompass different approaches. The next section compares different evaluation approaches used by researchers as outlined in the tables.

Evaluation Research Methodologies Characterized and Discussed

Several studies did not utilize an objective outcome variable to measure learning (Landow, 1989; Gay, Trumbull, & Mazur, 1991; Egan et al., 1989; Covey, 1990). Instead, the study focused on outcome which measured the success of searching through a hypermedia application (Gay, Trumbull, & Mazur, 1991; Egan et al., 1989), or used an essay exam which was judged with interrater reliability measures (Landow, 1989; Egan et al., 1989). With such a rich open-ended learning environment, what approach should be used to measure the impact of the experience on the learner?

The methodological question is often answered by inquirer, stakeholder, board members, community members, or the editor responsible for judging the inquiry (Guba & Lincoln, 1984). Often professionals will select an approach practiced within a tradition (cf. Jacob, 1987; Atkinson, Delamont, & Hammersley, 1988); this has practical value as researchers within a professional community can exchange results. Each approach has its advantages, but two general approaches as mentioned by Guba and Lincoln (1984), rationalistic[1] and naturalistic, in many ways can be characterized as dichotomies (see Figure 1). Although they are often mentioned as discrete categories, they may be more appropriately considered as ends of a continuum.

Regardless of the form of inquiry, Guba and Lincoln (1984) suggest that each approach has a set of criteria broadly defined into four categories which can be used to identify the trustworthiness of the study's findings (see Table 3). Truth value represents the confidence of the findings; applicability describes suitability of findings to similar inquiries with different setting/subject arrangement; consistency refers to the ability to replicate the study; and neutrality represents the degree to which the findings are established without biases.

Classified as rationalistic methods by Guba and Lincoln (1984), **experimental and quasi-experimental inquires** have a long tradition modeled after scientific forms of inquiry (Campbell & Stanley, 1963; Cook & Campbell, 1979). The distinction between the two rests on scheduling, either measurement or exposure. Where experimental designs are more tightly controlled, experimental rigor is not abandon in situations where, for example, random assignment to treatment is impossible. Instead quasi-experimental techniques are employed.

Formative evaluation was used in a few of the evaluation studies reviewed. Labeled a proactive approach by Stufflebean (1984), this technique offers systematic indication of the merits of specific options prior to completion of product development, in contrast to summative design which evaluates at the end of development.

Although Stufflebean's (1984) and Scriven's models go beyond mere product evaluation, Dick and Carey (1990) prescribe formative approaches that are appropriate for instructional products. The formative evaluation draws upon the systematic practices of quasi-experimental and experimental design. Yet, in practice, it takes on a range of techniques (cf. Covey, 1990; Egan et al., 1989). This technique seeks convincing evidence (Gagné & Briggs, 1979) and hence lacks correlates for all categories for comparison in Table 3.

Naturalistic inquiries use several techniques to guard against accusations of less rigor than rationalistic studies. For example, triangulation, a mechanism to cross-verify data with professionals of varying perspectives, is analogous to objectivity in rationalistic studies (Guba & Lincoln, 1984).

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Interrelationship of Characteristics of Hypermedia and Results from Evaluation Studies

Landow (1989) found, through naturalistic inquiry, an improvement in the quality and depth of responses to essay exams. Providing the learner with extension and construction ability (Kozma, 1991) may increase the learner's capacity to interrelate ideas. Node size and representation provided by links may also contribute to success. However, currently there is no evidence to support the notion that experience with hypermedia fosters transfer of learners' capacity to interrelate ideas in new situations.

As suggested by Landow (1989), hypermedia does facilitate learners' ability to control their own learning (Marchionini, 1988;Kinzie & Berdel, 1990; Hammond, 1989), but studies by Higgins and Boone (1990) found differences in the rate of gain between groups of different ability. Is the difference due to the interacting effects of: organization of the hypermedia application, control strategies utilized, and aptitude level of the learner? Is this control best fostered when it is used to control the content, or when it is used to control instructional strategies (e.g. examples, practice questions, amount of time needed, Merrill, 1983)?

Experimental and quasi-experimental approaches provide the researcher with a tradition of experience with which to draw upon. However, they have failed education with respect to comparison studies, an approach that is often used to investigate the effects of technology and traditional forms of teaching (Reeves, 1991;Clark, 1985; Clark, 1983). Using traditional approaches to design research studies require studies to be designed, planned, and implemented to maximize experimental variance (Kerlinger, 1973). Traditional approaches to evaluation may never provide a clear picture of instructional innovations when the focus of the study concerns process characteristics that require comparison studies to investigate the effects of the treatment (e.g. linear over nonlinear acquisition, cf. Lanza & Rozelli, 1991; Mayes, Kibby & Watson, 1988). The quasi-experimental approach may provide effective research designs when research questions require temporal probes. Single group designs exist to measure persistence (or gain) of each treatment with a control measure to monitor maturity (e.g. design 8, Campbell & Stanley, 1963), or when an indication of comparative effects of distinctively different treatments is desired (Atkinson, 1968; Borg, 1984).

The disadvantage of quasi-experimental evaluation rests on the additional attention the evaluator must place on the threats to internal validity (without randomizing subjects to study group), or external validity (time requirement to conduct such a study), and the statistical requirement of reliable measures of outcome.

If hypermedia is viewed as a cognitive enhancer, must we change our instructional objectives from performance-oriented to content-oriented as Bonner (1988) suggests? Self-tests, consisting of synthesizers or analyzers, may aid self-discovery while tracing the learner's progress, providing developers with information that may assess progress. Gay and Raffensperger (1989) mention a creative alternative to objective measures giving students the capability to self-test their progress. It consists of a video segment with an instructional overlay. The learner is invited to self-test understanding in a graphic environment by manipulating variables, thus demonstrating understanding of the instruction.

A cognitive approach to instruction may reestablish when instructional prescriptions are defined (Winn, 1990). Winn asserts that prescriptions for cognitive instructional strategies are generated while the instruction is underway, as opposed to defining them early in the development cycle, as in behavioral instructional strategies. The teacher or designer must appropriately time the necessary intervention when practicing a cognitive approach to instruction. Either must monitor the engaged learner and provide mechanisms to change strategies when appropriate. This also suggests a formative design strategy to insure that the designer can monitor actual use of the system after implementation and respond accordingly with necessary changes based on actual use.

Planned interventions, depending on the way they are implemented (e.g., by the teacher instead of the application) may alter learners' success depending on attributes present at the time of the intervention. Evaluating additive effects of the interaction may require a model such as those used in library science (Saracevic, Mokros, & Su, 1990). This form of general model-specific model captures and measures the attributes of the interaction process and specific attributes of members participating in the interaction. This naturalistic approach, provides an analysis of what transpired during interaction without loss of descriptive power which typically occurs in a statistical study.

The effect of hypermedia on learner strategy formulation, although posed by many researchers when hypothesizing the value of hypermedia as an instructional medium, has not been evaluated. Similarly, evaluation of levels of instructional support is needed. Although hypermedia is designed to inspire the learner to control his/her own learning, instructional strategies designed to provide limited guidance, yet unending support, may remedy the problems associated with hypermedia.

Evaluation of Hypermedia at Lehigh University

Since September, 1989, faculty and staff of the Advanced Information Technologies Laboratory (AITL) of the College of Education at Lehigh University have been engaged in developing integrated hypermedia materials for a number of clients. The current major projects of the AITL, under the direction of Dr. Francis A. Harvey, are the Hypermedia Support System for the Bridge Fatigue Investigator (Hyper-BFI) and the Cities in Schools Hypermedia Development Project (CIS/HDP). In this section of the paper we will described current and planned evaluation efforts related to those projects.

Evaluation of the Hypermedia Support System for the Bridge Fatigue Investigator

The Hypermedia Support System for the Bridge Fatigue Investigator Project is a subproject of Lehigh's Center for Advanced Technologies for Large Structural Systems (ATLSS) sponsored by the National Science Foundation. The project is part of a program which, for the past five years, has been exploring the use of combinations of knowledge-based system technology and hypermedia technology for information utilization and dissemination, training, and technology transfer (see Harvey, 1990; Harvey, 1989).

The Bridge Fatigue Investigator (BFI) is an expert system designed to aid bridge inspection (Michalerya, Wilson, & Chen, 1990). An interdisciplinary team of subject matter experts (including the developers of BFI) and instructional designers is developing a hypermedia support system to train bridge inspectors in the use of BFI and to help professional engineers use BFI for post-inspection bridge analysis.

The Hyper-BFI Project is now in its beginning stages. Techniques used to support formative evaluation include using rapid prototyping to create a pre-prototype for team members to react to small slices of system development during team meetings. A special icon represented by an exclamation symbol is operational from any instructional screen. This is used to communicate problems with the screen directives, or navigational aids at any time during the course of instruction while a development team member is viewing the application. Additionally, a selected-response measure with Likert scale format is also being considered to gather feedback from users during pilot testing.

Evaluation design objectives at this stage concern local aspects of the system: the design of a reliable instrument which will measure learner attributions and beliefs with respect to the developing system (Clark, 1983), and the identification of specification misconceptions in design implementation. These evaluation mechanisms, where possible, will be incorporated into the pre-prototype hypermedia application as it is developed.

Evaluation of the Cities in Schools Hypermedia Development Project

The Cities in Schools Hypermedia Development Project has, for the past three years, been developing an integrated hypermedia training curriculum for Cities in Schools, Inc. (CIS), the nation's largest and most successful program addressing the needs of at-risk youth. A four-week, full-day integrated hypermedia training course for directors of CIS local projects has been developed which includes nearly 60 minutes of professionally produced motion video and approximately 500 still photographs on videodisc; over 500 pages of printed instructional resources and background material; and a comprehensive hypermedia computer program with several hundred computer-based instructional resource materials and navigational aids which allow both trainer and trainees to access, use, and interrelate computer-based, video, and print instructional materials (see Harvey, 1990; Harvey & Story, 1989).

A formative evaluation of the Cities in Schools Project Operations integrated hypermedia training course was carried out both during the training program for Cities in Schools trainers conducted at Lehigh in February, 1991 and during the initial training program delivered by Cities in Schools trainers in March, 1991 (Spokane, 1991). This study used both trained observers and videotape to gather a comprehensive picture of how the training course was used and how trainers and trainees responded to it. These observations were supplemented by open-ended feedback forms completed by trainers and trainees both during and after training.

Since Cities in Schools training programs are held monthly in the National Center for Partnership Development hypermedia training laboratory at Lehigh, ample opportunity is provided to conduct both formative evaluation of CIS hypermedia materials under development and summative evaluation of those materials already in use. A follow-up evaluation of the Cities in Schools Project Operations training course is planned for March, 1992 at Lehigh.

The Cities in Schools integrated hypermedia training course for executive directors of city-wide CIS programs now under development will incorporate in its software unobtrusive mechanisms for recording complete information about how individual users make use of the hypermedia (Story & Harvey, 1990). Each interaction with the software (selection of icon, text entry, use of navigational support tools, etc.) will be recorded and time-coded automatically. A printed record of the interaction between user and the hypermedia program will be recorded on disk and later printed out for analysis.

In both of these projects, the evaluation components are designed at the same time as the application is designed. Design, development, and evaluation are seen as parallel and mutually supportive activities. This approach may ameliorate the "trapped administrator" syndrome identified by Campbell (1977), whereby the administrator is faced with the design of an evaluation study after the program is fully developed and in place.

Conclusion

Evaluation often distorts our view of instructional programs and the benefits provided by new technologies (Reeves, 1991). Consequently, developers of instructional software and educators alike use public receptivity as a barometer of success for their new products. Unfortunately, this offers minimal support in acknowledging the product as providing efficacy in instructional environments.

The benefit associated with hypermedia evaluation research lies in the dissemination of relevant findings and impact of the findings to enhance future practice. Research designs implemented with a rationalistic approach need valid constructs and measures to accurately quantify the variables related to the focus of the study. Plausible rival hypotheses can offer rich descriptions by contradicting a study's findings as a natural consequence of using rationalistic methods (Reeves, 1991).

Naturalistic approaches have the potential to contribute rich descriptions needed to foster new ideas and provide insight. Guba and Lincoln (1984) offer three tests to determine if a naturalistic approach should be selected over rationalistic methods: 1) data from study to study can not be aggregated; 2) researcher has little control of extraneous variance; and 3) impact of research on practice is absent. By these standards hypermedia, and many other focused studies of technology, is an ideal topic for naturalistic evaluation.

Despite the correlation of judgement criteria between rationalistic and naturalistic approaches (Table 3), the procedures are very different. Naturalistic study requires exceedingly large quantities of data as the approach is inductive instead of deductive. (In fact, hypermedia has been used to track and to interrelate the various data repositories in a naturalistic evaluation, see Martin, 1991.) Practitioners must become aware of naturalistic approaches to evaluation, their limitations and potential benefit to retrofit development. In particular, how would naturalistic inquiries remedy Guba and Lincoln's three-test scenario? Could data be aggregated for comparative analysis? Could researcher methods be analyzed? How would naturalistic studies influence practice?

The review and analysis in this paper suggests that hypermedia requires an adaptive interactive research model to investigate the effects of treatment. It is probable that this model will incorporate elements of rationalistic and naturalistic approaches. Regardless of the method used to evaluate the effectiveness of hypermedia, a focus on communicating the results of the study will foster progress in hypermedia development for learning.

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References

Allison, Lesley, & Hammond, Nick (1990). Learning Support Environments: Rational and Evaluation. Computers in Education, 15, 137-143.

Atkinson, Paul, Delamont, Sara, & Hammersley, Martyn (1988). Qualitative Research Traditions: A British Response to Jacob, Review of Educational Research, 58,2, 231-250.

Atkinson, Richard C. (1968). Computerized Instruction and the Learning Process, American Psychologist, 23, 225-239.

Bonner, Jodi. (1988). Implications of Cognitive Theory for Instructional Design: Revisited. Educational Communications and Technology Journal, 36, 3-14.

Borg, Walter (1984). Dealing with Threats to Internal Validity That Randomization Does not Rule Out. Educational Researcher, December, 11-14.

Bush, Vannevar (1945). As We May Think. Atlantic Monthly 176 (1). 101-108.

Campbell, Donald T., & Stanley, Julian C. (1963). Experimental and Quasi-Experimental Designs for Research. Dallas: Houghton Mifflin Company.

Campbell, Donald T. (1977). Reforms as Experiments, Readings in Evaluation Research (2nd Ed.), NY: Russel Sage Foundation.

Clark, Richard E. (1985). Evidence for confounding in Computer-Based Instruction Studies: Analyzing the Meta-Analyses, Educational Communication and Technology Journal, 33, (4), 249-262.

Clark, Richard E. (1983). Reconsidering Research on Learning from Media, Review of Educational Research, 53, 4, 445-459.

Cook, Thomas, D. & Campbell, Donald T. (1979). Quasi-Experimental Design and Analysis Issues for Field Settings. Boston, MA: Houghton Mifflin Company.

Covey, Preston K. (1990). Art or Forgery? The Strange Case of Han Van Meegeren A Videodisc for Aesthetics and Art History. Journal of Computing in Higher Education, 2, (1), 3-31.

Dick, Walter, & Carey, Lou (1990). The Systematic Design of Instruction (3rd ed.). New York: Harper Collins Publishers.

Egan, Dennis E., Remde, Louis M., Gomez, Landauer, Thomas K., Eberhardt, Jennifer, & Lochbaum, Carol C. (1989). Formative Design-Evaluation of SuperBook, ACM Transactions on Information Systems, 7, (1), 30-57.

Gagné, Robert M., & Briggs, Leslie, J. (1979). Principles of Instructional Design (2nd ed.). New York: Holt, Rinehart & Winston.

Gay, Geri, & Raffensperger (1989). Considerations and Strategies in the Design of Interactive Multimedia Programs. Academic Computing, September, 24-58.

Gay, Geri, Trumbull, Deborah, Mazur, Joan (1991). Designing and Testing Navigational Strategies and Guidance Tools for a Hypermedia Program. Journal of Educational Computing Research,7, (2) 189-202.

Goldman, Elizabeth, & Barron, Linda (1990). Using Hypermedia to Improve the Preparation of Elementary Teachers. Journal of Teacher Education, 41, (3), 21-31.

Guba, Egon G. & Lincoln, Yvonna S. (1984). Epistemological and Methodological Bases of Naturalistic Inquiry. In G. F. Madaus, M. Scriven, D.L. Stufflebeam (Eds.), Evaluation Models Viewpoints on Educational and Human Services Evaluation, (pp. 311-333). Hingham, MA:Kluwer-Nijhoff Publishing.

Hammond, Nick (1989). Hypermedia and Learning: Who Guides Whom? In H. Maurer (Ed.), Computer Assisted Learning 2nd International Conference, ICCAL '89 Dallas Tx., USA May 1989 Proceedings, (pp. 167-181), Berlin, Germany: Springer-Verlag.

Hammond, Nick, & Allinson, Lesley (1988). Development and Evaluation of a CAL System for Non-Formal Domains: The Hitch-Hiker's Guide to Cognition, Computers in Education, 12, (1), 215-220.

Harvey, F. A., (1990). Integrating hypermedia and knowledge-based system technologies for training and information dissemination. In Proceedings of the 32nd international conference of the Association for the Development of Computer-Based Instructional Systems, San Diego, CA, October 28 -- November 1, 1990, 39. Columbus, OH: Association for the Development of Computer-Based Instructional Systems, Ohio State University.

Harvey, F. A., (1990). Designing hypermedia training materials to optimize learning. In Proceedings of the 32nd international conference of the Association for the Development of Computer-Based Instructional Systems, San Diego, CA, October 28 -- November 1, 1990, 57. Columbus, OH: Association for the Development of Computer-Based Instructional Systems, Ohio State University.

Harvey, F. A., (1989). Planning and developing an intelligent information integration and management system. In Proceedings of the 31st international conference of the Association for the Development of Computer-Based Instructional Systems, Arlington, VA, November 12-16, 1989, 267-71. Bellingham, WA: Association for the Development of Computer-Based Instructional Systems, Western Washington University.

Harvey, F. A., and Story, W.B., Jr. (1989). Developing hypermedia training materials for a national human services coordination program for at-risk youth. In Proceedings of the 31st international conference of the Association for the Development of Computer-Based Instructional Systems, Arlington, VA, November 12-16, 1989, 38-43. Bellingham, WA: Association for the Development of Computer-Based Instructional Systems, Western Washington University.

Higgins, Kyle, & Boone, Randall (1990), Hypertext Computer Study Guides and the Social Studies Achievement of Students with Learning Disabilities, Remedial Students, and Regular Education Students, Journal of Learning Disabilities, 23, (9), 529-540.

Horton, Steven V., Boone, Randall A., Lovitt, Thomas C. (1990). Teaching Social Studies to Learning Disabled High School Students: Effects of a Hypertext Study Guide, British Journal of Educational Technology, 21, (2), 118-131.

Jacob, Evelyn (1987). Qualitative Research Traditions: A Review, Review of Educational Research, 57, (1), 1-50.

Jones, Robert A. (1990). To "Criss-Cross in Every Direction"; or, Why Hypermedia Works, Academic Computing, January, 20-21;30;53.

Kerlinger, F. N. (1973). Foundations of Behavioral Research (2nd ed.). New York: Holt, Rinehart and Winston.

Kinzie, Mable B., & Berdel, Richard L. (1990). Design and Use of Hypermedia Systems, Educational Technology Research and Development, 38, (3), 61-68.

Kozma, Robert B. (1991). Learning with Media. Review of Educational Research, 61, 2, 179-211.

Landow, George P. (1989). Hypertext in Literary Education, Criticism, and Scholarship. Computers and Humanities, 23, 173-198.

Lanza, Antonietta, & Roselli, Teresa (1991). Effects of the Hypertextual Approach versus the Structured Approach on Students' Achievement. Journal of Computer-Based Instruction, 18, (2), 48-50.

Locatis, Craig, Letourneau, Gary, & Banvard, Richard (1989). Hypermedia and Instruction, Educational Technology Research and Development, 37, (4), 65-77.

Michalerya, W.D., Wilson, J.L., & Chen, S.S. (1990). "The Bridge Fatigue Investigator - A Knowledge-Based System for Bridge Inspectors," Proceedings of the Seventh Annual International Bridge Conference, Pittsburgh, PA, June, Paper No. 90-49.

Marchionini, Gary (1988). Hypermedia and Learning: Freedom and Chaos, Educational Technology, November, 8-12.

Martin, C. Dianne (1991). New Findings from Qualitative Data Using Hypermedia: Microcomputers, Control and Equity, Computers in Education, 16, (3), 219-227.

Mays, J. Terence, Kibby, Michael R., & Watson, Hugh (1988). The Development and Evaluation of a Learning-by-Browsing System on the Macintosh, Computers in Education, 12, (1), 221-229.

Merrill, M. D. (1983). Component Display Theory. In C.M. Reigeluth (Ed.) Instructional Design Theories and Models: An Overview of Their Current Status. New Jersey: Erlbaum.

Moline, Judi, Benigni, D., & Baronas, Jean (Eds.). (1990). Proceedings of the Hypertext Standardization Workshop January 16-18, 1990 National Institute of Standards and Technology. Washington, D.C: US Government Printing Office.

Reeves, Thomas C. (1991). Ten Commandments for the Evaluation of Interactive MultiMedia in Higher Education, Journal of Computing in Higher Education, 2, (2), 84-113.

Romiszowski, Alexander J. (1990). The Hypertext/Hypermedia Solution--But What Exactly is the Problem? In D.H. Jonassen & H. Mandl (Eds.). Designing Hypermedia for Learning, Berlin, Germany: Springer-Verlag.

Rossi, Peter, H., & Freeman, Howard E. (1989). Evaluations A Systematic Approach (4th ed.). Newbury Park: Ca: Sage Publications.

Saracevic, Tefko, Mokros, Hartmut, & Su, Louise. (1990). Nature of Interaction Between Users and Intermediaries in Online Searching: A Qualitative Analysis, In D. Henderson (Ed.), Proceedings of the 53rd Annual Meeting of the American Society for Information Science, (pp. 47-54). Medford, New Jersey: Learned Information, Inc.

Skinner, B.F. (1986). Programmed Instruction Revisited. Phi Delta Kappan 68, 103-110.

Spokane, A., Davison, R. M., Wise, D., and Hart, R. C. (1991). Formative evaluation of Project Operations trainer training and trainee training. (Tech. Rep. No. CIS/HDP 91.05) Bethlehem, PA: Lehigh University, Cities in Schools Hypermedia Development Project.

Story, William B., Jr., and Harvey, F. A., (1990). Techniques and procedures for the transparent automatic collection of data for hypermedia-based research. In Proceedings of the 32nd international conference of the Association for the Development of Computer-Based Instructional Systems, San Diego, CA, October 28 -- November 1, 1990, 393-5. Columbus, OH: Association for the Development of Computer-Based Instructional Systems, Ohio State University.

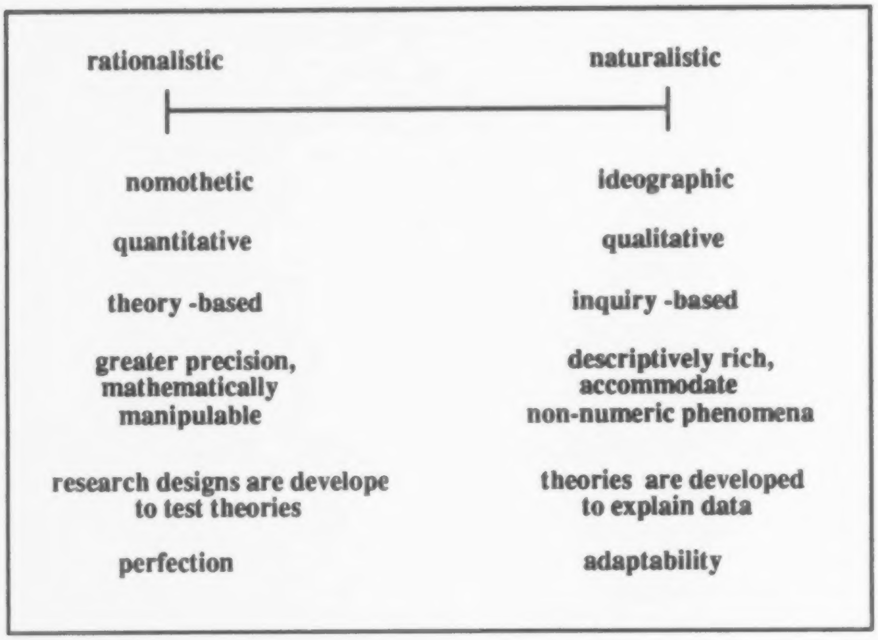
Stufflebean, Daniel L. (1984). The CIPP Model for Program Evaluation. In G. F. Madaus, M. Scriven, D.L. Stufflebeam (Eds.), Evaluation Models Viewpoints on Educational and Human Services Evaluation, (pp. 311-333). Hingham, MA:Kluwer-Nijhoff Publishing.

Tripp, Steven D., & Roby, Warren. (1990). Orientation and Disorientation in a Hypertext Lexicon, Journal of Computer-Based Instruction, 17, (4), 120-124.

Winn, William (1990). Some implications of cognitive theory for instructional design. Instructional Science, 19, 53-69.

Footnotes

[1] Guba and Lincoln (1984) use the term "rationalistic" to reference forms of conventional inquiry such as experimental and quasi-experimental forms of evaluation.



rationalistic	naturalistic
nomothetic	ideographic
quantitative	qualitative
theory -based	inquiry -based
greater precision, mathematically manipulable	descriptively rich, accommodate non-numeric phenomena
research designs are develope to test theories	theories are developed to explain data
perfection	adaptability

Figure 1: Comparison of rationalistic and naturalistic methodologies

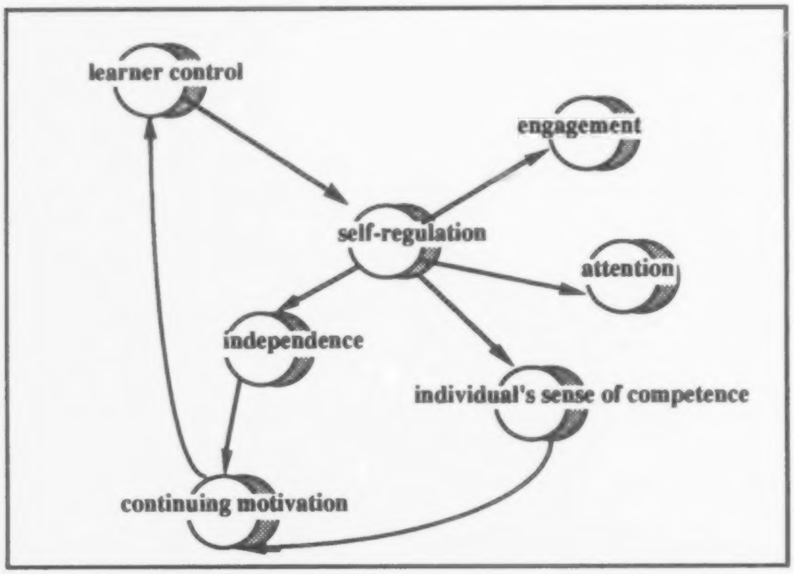

learner control
engagement
self-regulation
attention
independence
individual's sense of competence
continuing motivation

Figure 2: Relationship between learner control (primary characteristic) and self-regulation (secondary characteristic).

Table 1

Characteristics of hypermedia (Process) and expected Outcome (Product)

Cited Literature	Process Characteristic	Outcome Characteristic
Jones (1990)	Hypermedia more accurately reflects the way the mind actually works, i.e., thru the association of ideas rather than in a linear or hierarchical fashion.	Evidence supporting nonlinear over linear acquisition.
Kozma (1991)	Hypermedia facilitates application and transfer of complex knowledge to new situations via multiple exploration on either thematic or conceptual dimensions.	Evidence supporting knowledge representation along multiple instead of singular conceptual dimensions. Assembly of representations instead of retrieval of schema.
Kozma (1991)	Hypermedia provides learner with extension and construction ability.	Evidence supporting Hypermedia prompts learners to think about ideas, how they are interrelated, structured.
Locatis, Letourneau, & Banvard (1989)	Hypermedia requires linking with specific forms of instructional support.	Evidence which suggests success based on different forms of linking.
Locatis, Letourneau, & Banvard (1989)	Hypermedia node size and representation may affect use.	Evidence which indicates that different arrangements aid/impact success rates.
Locatis, Letourneau, & Banvard (1989); Hammond (1989)	Hypermedia open-ended experience may be different depending on previous exposure to content domain and aptitude level.	Evidence which indicates novice, intermediate, and expert skill require/use different treatment.
Marchionini (1988); Kinzie & Berdel (1990); Hammond (1989)	Hypermedia facilitates users' ability to control their own learning.	Evidence which indicates this is beneficial.
Marchionini (1988)	Hypermedia offers new ways of learning how to learn.	Evidence of increase in strategies for the learner.
Marchionini (1988)	Potential to alter roles of teachers and learners and facilitate interaction between them.	Evidence of Human-Computer-Intermediary support.

Table 2
Selected Evaluation Research Table 1 of 2

Study	Approach	Study Focus	Study Supported Research Hypothesis	Content	Subjects	Multiple Measures
Covey (1990)	Formative	Exploring knowledge evidentiary issues: attribution and critical analysis in study of visual art	no	Fine Art	College undergraduates	no
Egan et al. (1989)	Formative	Print search compared to computer search	no	Texas Legal Code	College undergraduates (with 1 or more statistics courses)	yes
Egan et al. (1989) Evaluation Study II.	Formative (between subjects measurement)	Added open ended questions, affective rating measures	yes	Texas Legal Code	College undergraduates (with 1 or more statistics courses)	yes
Egan et al. (1989) Evaluation Study III.	Formative	Smaller screen version compared to print search	yes	Texas Legal Code	College undergraduates (with 1 or more statistics courses)	yes
Gay, Trumbull, Mazur (1991)	Quasi-experimental (case study using volunteers)	Interaction of choice of search mode and Learning Study Skills	not clear	Cultural Entomology	College undergraduates	no
Goldman & Barron (1990)	Naturalistic	Affective measures, traditional test performance, teaching methods improvement	mixed	Mathematics teaching methodology	Preservice college students	no
Hammond, & Allinson (1988)	Formative	Performance	n/a	Cognitive Psychology	College undergraduates	no
Higgins & Boone (1990)	Quasi-experimental (pretest-posttest & retention, random assignment)	Comparing delivery modes: Lecture, Computer Study Guide, & both	no	Social Studies	High school students: regular, learning disabled, & remedial.	yes

Table 2a
Selected Evaluation Research Table 2 of 2

Study	Approach	Study Focus	Study Supported Research Hypothesis	Content	Subjects	Multiple Measures
Higgins & Boone (1990) Study II	Quasi-experimental (follow-up A-B-A)	Increase in test performance using study guide as follow-up instruction.	yes	Social Studies	Learning disabled, & remedial	yes
Horton, Boone, Lovitt (1990)	Quasi-experimental (small case)	Increase in comprehension using instructional sequencing in study guide	yes	Washington State History	Learning disabled high school students	yes
Landow (1989)	Naturalistic, ethnographic	Increase student's analytical skills, and develop ability to assimilate breadth of information	yes	Survey of English Literature, 1700 to the Present	College under-graduates	n/a
Lanza & Roselli (1991)	Quasi-experimental (post-test case study)	Effectiveness of hypertext instruction vs CAI	not clear	Pascal programming	College under-graduates	no
Mays, Kibby, & Watson (1988)	Experimental	Comparison of hypermedia and traditional teaching	no	Geology	College under-graduates	no
Mays, Kibby, & Watson (1988) Study II	Naturalistic	Protocol Analysis	not clear	Geology	College under-graduates	
Tripp & Roby (1990)	Experimental (post-test)	Visual metaphors increase learning, rote learning is not more effective with hypermedia	no	Japanese-English lexicon	College graduates, and under-graduates	no

n/a = not applicable

Table 3
Criteria for Judging the Trustworthiness of the Findings of an Evaluation Study

Criteria for Judgement	Approach			
	Experimental	Quasi-Experimental	Formative	Naturalistic
Truth Value	Internal Validity	Internal Validity	Convincing	Credibility
Applicability	External Validity	External Validity		Transferability
Consistency	Reliability	Reliability		Dependability
Neutrality	Objectivity	Objectivity		Confirmability

Note. The data in column 1,2 and 5 are from "Epistemological and Methodological Bases of Naturalistic Inquiry" by E. G. Guba and Y.S. Lincoln , Evaluation Models (p. 326) in G.F. Madaus, M. Scriven, and D.L. Stufflebeam, (Eds.), 1983, Boston: Kluwer-Nijhoff Publishing. Adapted by the authors.

Title:

The Adoption and Diffusion of an Electronic Network for Education

Authors:

Julie Hamilton
Ann Thompson

The Adoption and Diffusion of an Electronic Network for Educators

by

Julie Hamilton
Creighton University

Dr. Ann Thompson
Iowa State University

Background

The professional isolation of educators has long been a problem. Dan Lortie describes the "egg crate" nature of teaching, referring to the fact that typically, teachers are isolated in their classrooms and have little opportunity for interaction with other teachers and experts in their fields (Lortie,1975). Supporting Lortie's findings, Goodlad (1983) reports that teachers are generally confined to their classrooms and are unable to converse with other educators about problems or concerns.

The capabilities provided by electronic communication networks provide a possible solution for the professional isolation of teachers. Although research suggests electronic communication networks are currently being used effectively by some educators,the diffusion process of such networks has not been widely spread. With the development of electronic communication networks, an adoption/diffusion cycle occurs as potential users become aware of the innovation, judge its relative value, make a decision based on that judgement, implement or reject the innovation, and seek confirmation of the adoption/rejection decision. Electronic communication networks are one of the most recent technologies to begin the diffusion process through the educational system. Research on electronic communication networks is valuable to educators developing and managing networks. More specifically, research determining characteristics of early adopters and how they judge the value of such systems is necessary because this information helps researchers and developers understand and improve use of the innovation. The adoption/diffusion theory (Rogers,1986) provides a framework in which this research can be conducted.

Rogers (1986) stated that the four main elements in the adoption/diffusion process are the innovation, communication channels, time and the social system. Rogers defined an innovation as an idea, practice or object that is perceived as new by an individual. According to Rogers (1986), diffusion is the process by which an innovation makes its way through a society or specific group of people. The process of diffusion includes 3 components: 1) the innovation, 2) an individual or other unit of adoption who knows about or has experience with the innovation, and 3) a communication channel which provides a means of information exchange between the parties. Communication channels include two types: 1) mass communication channels, 2) interpersonal channels.

Diffusion is concerned primarily with the innovation and the adoption of the innovation. Following the introduction of the innovation, an evaluation process takes place on the part of the consumer. Diffusion of an innovation through a social system is determined by characteristics of the adopter and the perceived value of the innovation.

Early adopters have been found to possess common personal characteristics. In past research common characteristics of early adopters have been found in the categories of socioeconomic status, communication behavior, and personality traits. More specifically, research has concluded that personal characteristics early adopters have in common are their:

1. Education Level
2. Social Status
3. Social Participation

4. Cosmopolitan Outlook
5. Mass Media Use
6. Personal Communication
7. Degree of Innovation Information Seeking
8. Attitude Toward Change
9. Attitude Toward Risk
10. Aspirations
11. Attitude Toward Fatalism

One of the important individual differences in length of the innovation-decision period is on the basis of adopter category. Early adopters have a shorter innovation-decision period than later adopters. The first individuals to adopt a new idea (the early adopters) do so not only because they become aware of the innovation somewhat sooner than their peers, but also because they require fewer months and years to move from knowledge to decision (Rogers and Shoemaker, 1971).

Early adopters model change agents. A change agent is a professional who influences innovation-decisions in a direction deemed desirable by a change agency (Rogers and Shoemaker, 1971). Early adopters of innovations play an important role in the diffusion process. Their initiative to adopt an innovation is observable by the later adopters, especially the early majority. This observance by the later adopters influences their adoption and thus the success of the innovation.

The early adopters also serve as a filter for innovations. If the early adopters have a poor perception of an innovation, the innovation will be filtered out of the system but if the early adopters perceive the innovation as worthy they filter the innovation through the social system. Therefore, early adopters initial perceptions of an innovation is an important element in the diffusion process.

According to Rogers (1986), adopters' perceptions of an innovation are also a vital element in the diffusion process. He has concluded that there are five dominant characteristics that adopters use to judge the value of an innovation. These characteristics include:

> Relative Advantage - the degree to which an innovation is perceived as being better than the idea it supersedes. The relative advantage of a new idea, as perceived by members of a social system, is positively related to its rate of adoption.
> Compatibility - the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of the receivers. The compatibility of a new idea, as perceived by members of a social system, is positively related to its rate of adoption.
> Triability - the degree to which an innovation may be experimented with on a limited basis. The triability of a new idea, as perceived by members of a social system, is positively related to its rate of adoption.
> Complexity - the degree to which an innovation is perceived as being relatively difficult to understand and use. The complexity of a new idea, as perceived by members of a social system, is negatively related to its rate of adoption.
> Observability - the degree to which the results of an innovation are visible and easily communicated to others. The observability of a new idea, as perceived by members of a social system, is positively related to its rate of adoption.

The adoption, implementation, and utilization of new communication technologies, such as electronic communication networks, can be studied effectively based on the theoretical framework of the adoption/diffusion theory. Diffusion of an innovation is determined by personal characteristics of adopters in a social system and their perceived value of the innovation. In order for an innovation to be successfully adopted within a social system a diffusion process, the process by which an innovation makes its way through a society or specific group of people, must occur. In this study, adoption diffusion theory was used as the theorectical base to study early adopters use of an electronic communication network for teachers.

The electronic communication network used to conduct this research is entitled the Electronic Educational Exchange (EEE). The college of Education at Iowa State University has developed an electronic network to bridge the gap between the world of practice in the classroom and education faculty at the university. The EEE is designed to serve the following purposes:

- I. Provide a convenient method for the exchange of ideas between student teachers, practicing teachers and Iowa State faculty.
    - A. Decrease the sense of isolation often encountered by student and practicing teachers.
    - B. To make faculty expertise readily available to student and practicing teachers.
    - C. To increase faculty awareness of the problems frequently encountered by student and practicing teachers.
- II. Provide telecommunications experience for student teachers, practicing teachers, and Iowa State faculty.

Problem

The manner in which educational institutions are organized generally restricts teachers to their classrooms, which limits interaction with one another. Teacher isolation is currently a major concern within the field of education. Many communication formats such as journals, office memos and school calenders serve as methods of mass communication, but alternative methods that facilitate interpersonal communication must be examined.

Electronic communication networks are relatively new systems that have been proposed as one method to decrease teacher isolation. Although research has begun to indicate that electronic networks seem to be a "natural fit" to meet many needs in the teaching profession, networks haven't been adopted and diffused on a large scale basis. There is a need to collect data on characteristics of early adopters to better understand the people and why they use electronic networks as a communication device. There is also a need to understand the evolution of network use. In order to determine this information a theoretical framework must be implemented. The adoption/diffusion theory provides us with the framework needed in order to evaluate the adopters of electronic networks, their use of the networks and the evolution of electronic communication networks. The data will assist individuals and organizations in the implementation and management of electronic communication networks.

Study Procedures

In order to conduct this study, a list of the most frequent EEE users in the Spring of 1990 was generated. The most frequent or heavy users of the system were defined as early adopters of the innovation.

A total of 35 subjects were selected. The subjects consisted of 4 Iowa State professors, 4 Iowa State graduate students, 4 Iowa State student teachers, 2 Iowa State pre-service teachers, 1 professor outside of the university, and 20 educators from the state of Iowa and surrounding states.

A questionnaire was used in this study. Research has suggested that personal characteristics early adopters have in common are: education level, social status, social participation, cosmopolitian outlook, mass media use, personal communication, degree of innovation information seeking, aspirations and attitude toward change, risk and fatalism. Therefore, the questionnaire was designed to collect data in these areas. In addition, research suggests that perceptions of an innovation directly affect the diffusion process. An additional section of the questionnaire allowed the early adopters to rate their initial and current perceptions of the EEE in five categories. The categories included relative advantage, compatibility, triability, complexity and observability.

Results

In general, the results of the study with respect to characteristics of early adopters were in agreement with Rogers. The average early adopter of the Electronic Educational Exchange can be described as:

1. possessing a Masters Degree or another degree beyond BA
2. having an income of $30,000 or more
3. working as a classroom teachers
4. being approximately 39 years old
5. having 11 or more years in the field of education
6. contacting teachers outside of their school frequently
7. using various forms of media frequently
8. having a positive attitude toward technology
9. having an attitude that risk is necessary in life
10. having a neutral attitude on fatalism

A significant finding in the study involved the initial and current perceptions of the Electronic Educational Exchange. The subjects were asked to rate the EEE, based on 5 categories, using a five point scale ranging from very high to very low. The mean of the initial perception was 2.41 indicating that the users felt the system ranked between average and high. Later, the subjects were asked to rate their current perception of the system. A mean of 1.92 was calculated as the current perception of the system, indicating that the users had a significantly higher perception of the EEE than when they began using the system. Overall, the data suggested that early adopters of the EEE were receiving the services they were seeking from the system. Results are reported in Table 1.

Table 1. Early Adopter's Initial/Current Perceptions of the EEE

Perception	N	Mean	S.D.	T	2-Tailed Probability
Initial Perception	29	2.41	.682	3.31	.001
Current Perception		1.92	.476		

Message content and with whom individuals communicated was also compiled and evaluated. The subjects were asked to comment on "with whom they communicate most frequently" and "what their message content entails". The responses were similar. Teachers, Iowa State faculty, and graduate students were the most common users mentioned as communication partners on the EEE. Media specialists and the system operator were also mentioned.

Message content was also similar among users; content categories included research, teaching ideas, educational technology, classroom management and personal messages. This suggested that the system was being used for professional development purposes by the users.

Educational Implications

Although research suggests electronic communication networks are currently being used effectively by some educators, the diffusion process of such networks has not been widely spread.

Research suggests that early adopters play a vital role in the diffusion process. They serve as a filter for the network. According to Rogers (1986), if the early adopters have a poor perception of an innovation, the innovation will be filtered out of the system but if the early adopters perceive the innovation as worthy they filter the innovation through the social system. Early adopters of the EEE were asked to report their initial and current perception of the system. The mean of the initial perception was 2.41 indicating that the users felt the system ranked between average and high. Later, the subjects were asked to rate their current perception of the system. A mean of 1.92 was calculated as the current perception of the system, indicating that the users had a significantly higher perception of the EEE than when they began using the system. Overall, the data suggested that early adopters of the EEE were receiving the services they were seeking from the system.

Rogers (1986) stated that early adopters of innovations possess certain characteristics and the present study supports his findings. In general, the study found early adopters of the Electronic Educational Exchange to possess these characteristics described by Rogers. Therefore, it is suggested to network developers that they individually seek individuals possessing characteristics similar to those of the early adopters of the EEE. Their use will increase the system's observability therefore, enhancing the diffusion process.

References

Dede C. (June,1989). Future use of technology in education. Paper presented at the Annual Meeting of the National Education Conference, Nashville, TN.

Goodlad, J. (1983). A study of schooling: Some implications for school improvement. Phi Delta Kappan, 64(8), 552-558.

Lortie, D. (1975). Schoolteacher. Chicago: University of Chicago Press.

Rogers, E.M. (1986). Communication technology. New York: Free Press.

Rogers, E. M., & Shoemaker F. (1971). Communication of Innovations. New York: Free Press.

Title:

The Data Collector: A Qualitative Research Tool

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Sandra V. Turner

The Data Collector: A Qualitative Research Tool

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Researchers using both qualitative and quantitative data are concerned with the ways in which information can best be organized, analyzed and shared. Software tools for analyzing quantitative data have been widely available since the earliest days of computers, but software that assists the qualitative researcher in the analysis of textual data is relatively new.

During this session we will demonstrate a HyperCard program for the Macintosh, the *Data Collector*, which we designed for our own research and have now made available to other researchers through Intellimation. The *Data Collector* is a tool for organizing and analyzing textual data obtained from observations, interviews, surveys, and other documents. The program also includes a component called the *BiblioStack* that facilitates note-taking for a literature review. These two components may be used together or independently.

This paper describes the criteria for the program's development, the rationale for using HyperCard, and the features of both the Data Collector stack and the BiblioStack.

Criteria for the Program's Development

Wellman and Sim (1990) have identified several criteria for evaluating software meant to be used in qualitative research. These criteria include flexibility, preserving the richness of the material, ease of use, and analytic power.

Flexibility. The researcher should be able to change and add code words because objectives and understanding change during the analytic process.

Preserve richness of material. Wellman and Sim recommend that textual analysis software allow the researcher to examine the material in context and to compare similar texts for analysis.

Ease of use. Researchers should be able to use the software without having to depend on an expert consultant.

Analytic power. Textual analysis software should help to identify classes of concepts, do complex Boolean searches, and provide output in a form that facilitates analysis.

In designing this program we have made every effort to take these criteria into consideration.

Why HyperCard?

Both the Data Collector and the BiblioStack are written in HyperCard, an authoring program for the Macintosh that allows access to a large body of information in a variety of different ways. An important characteristic of HyperCard is that any piece of information can be linked to any other piece of information, creating a web of related ideas. Because HyperCard facilitates the linking of many disparate pieces of text, it seemed to us an ideal environment for organizing and analyzing qualitative data.

Features of the Data Collector Stack

The Data Collector stack has as its backbone a single card where you can enter any kind of textual data (Figure 1). Data may be typed into a scrolling Notes field or imported into the Notes field from a word processor. In addition to the Notes field, there are fields for the type of data (interview, observation, survey, historical document), general site description, the specific setting, the name of the researcher and the date.

Boolean searching. HyperCard's normal Find function has been enhanced to include Boolean searching using multiple *and's* and *or's*. The Find and Find Again options in the Utilities menu locate all occurrences of a specified word or phrase. The results of the search may be viewed on the screen or copied to a specific topic card created by the researcher.

Coding. The Coding menu allows you to code a document, as well as to add, change or delete code words during the analysis process. First, enter your own code words. Then you click on a code word in your list and click on the paragraph to be coded. The code word is placed within brackets at the beginning of that paragraph.

Copying text to a topic card. To facilitate the data reduction process and in order to construct themes and domains for further analysis, text may be copied to topic cards, thereby reducing the data to smaller, more manageable divisions for further analysis. To do this, highlight the selected text using the mouse and click the Copy Text button. You choose whether to copy text to an existing topic card or to a newly created topic card. When the text is copied to the card, information identifying the source of the data accompanies it. To continue the data reduction process, the text on the topic cards can be coded and even copied to a new topic card.

Comparative viewing. The Compare Cards button allows you to view two cards on the screen simultaneously. To mark cards for comparative viewing, click on the dotted corner on the card; the corner will turn down. The marked cards are then placed in a separate stack in another window on the screen for easy comparison with the original stack. The ability to compare documents aids in the triangulation process. While in this mode, text from either window may be copied to new or existing topic cards.

Importing and exporting text. The Export and Import items in the Utilities menu provide a means for transferring text files to and from word processing programs.

Features of the BiblioStack

The second component of the *Data Collector* program is the BiblioStack, which facilitates note-taking for a literature review. From the BiblioStack you can create reference cards containing information about a citation along with any number of note cards related to that citation.

Reference cards. The reference card for each bibliographic entry includes standard bibliographic information, a field for key words, and a field for the citation abstract (Figure 2). The complete citation is placed in one field, thus you can enter it using either APA, Chicago, MLA or any other style. Citations can be directly exported to a word processing program to create a bibliography or list of references. No retyping is needed if the citation has been entered into the BiblioStack using the proper style, although additional formating may be necessary.

Note cards. Each reference card has associated with it any number of note cards. Each note card contains a field for notes and a field for key words relevant to the particular note (Figure 3).

Boolean searching. You can perform Boolean searches to find any word or phrase in a reference card or note card. The results of the search are viewed on the screen and may be printed out.

Topic stacks. Reference cards meeting a particular search criteria can be marked and copied, with all their note cards, to a new independent topic stack. In this way you can create separate bibliographic stacks for different research projects from your original stack.

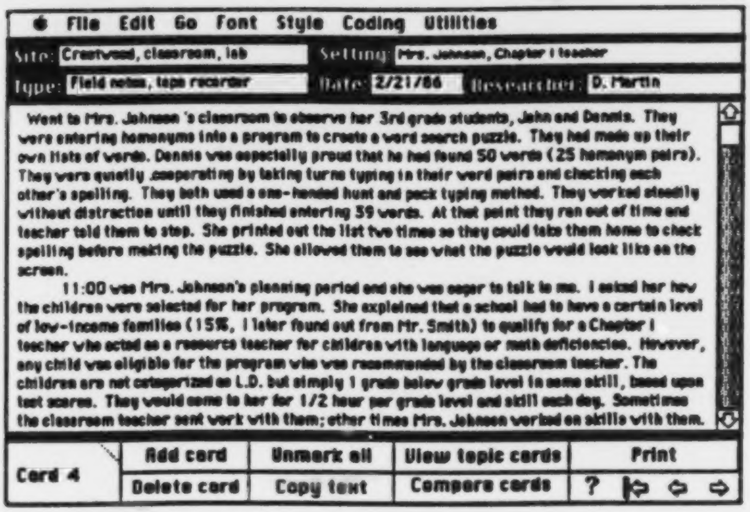
Conclusion

Although originally designed for our own use, we believe the *Data Collector* demonstrates the viability of using technology to meet the needs of the qualitative researcher. It is important to remember, though, that the software is simply a tool for organizing and managing the data; the researcher must still do the analysis. The researcher must develop the relevant coding categories, identify emerging themes, and support his or her interpretations from the data. However, software tools such as this one can simply the mechanical aspects of that task considerably.

References

Wellman, B., & Sim, S. (1990, February). Integrating textual and statistical methods in the social science. *CAM Newsletter*, pp. 1-3, 10-11.

Turner, S., & Handler, M. (1991). *The data collector: A qualitative research tool* [software and manual]. Santa Clara, CA: Intellimation.

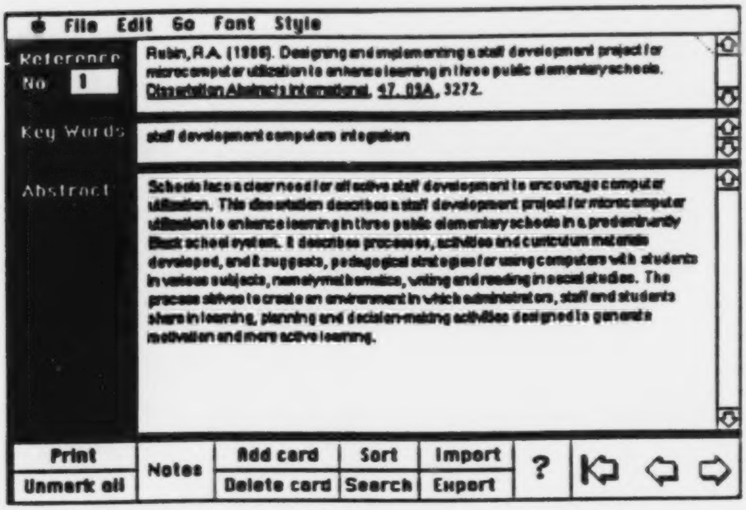


Site: Crestwood, classroom, lab
Setting: Mrs. Johnson, Chapter I teacher
Type: Field notes, tape recorder
Date: 2/21/86
Researcher: D. Martin

Went to Mrs. Johnson 's classroom to observe her 3rd grade students, John and Dennis. They were entering homonyms into a program to create a word search puzzle. They had made up their own lists of words. Dennis was especially proud that he had found 50 words (25 homonym pairs). They were quietly cooperating by taking turns typing in their word pairs and checking each other's spelling. They both used a one-handed hunt and peck typing method. They worked steadily without distraction until they finished entering 39 words. At that point they ran out of time and teacher told them to stop. She printed out the list two times so they could take them home to check spelling before making the puzzle. She allowed them to see what the puzzle would look like on the screen.

11:00 was Mrs. Johnson's planning period and she was eager to talk to me. I asked her how the children were selected for her program. She explained that a school had to have a certain level of low-income families (15%, I later found out from Mr. Smith) to qualify for a Chapter I teacher who acted as a resource teacher for children with language or math deficiencies. However, any child was eligible for the program who was recommended by the classroom teacher. The children are not categorized as L.D. but simply 1 grade below grade level in some skill, based upon test scores. They would come to her for 1/2 hour per grade level and skill each day. Sometimes the classroom teacher sent work with them; other times Mrs. Johnson worked on skills with them.

Figure 1

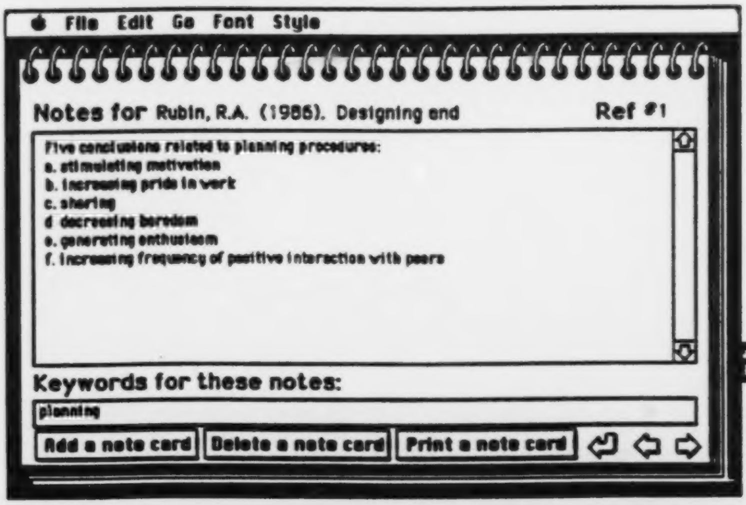


Reference No: 1
Rubin, R.A. (1986). Designing and implementing a staff development project for microcomputer utilization to enhance learning in three public elementary schools. Dissertation Abstracts International, 47, 09A, 3272.

Key Words: staff development computers integration

Abstract: Schools face a clear need for effective staff development to encourage computer utilization. This dissertation describes a staff development project for microcomputer utilization to enhance learning in three public elementary schools in a predominantly Black school system. It describes processes, activities and curriculum materials developed, and it suggests, pedagogical strategies for using computers with students in various subjects, namely mathematics, writing and reading in social studies. The process strives to create an environment in which administrators, staff and students share in learning, planning and decision-making activities designed to generate motivation and more active learning.

Figure 2



Notes for Rubin, R.A. (1986). Designing and
Ref #1

Five conclusions related to planning procedures:
a. stimulating motivation
b. increasing pride in work
c. sharing
d decreasing boredom
e. generating enthusiasm
f. increasing frequency of positive interaction with peers

Keywords for these notes:
planning

BEST COPY AVAILABLE

Figure 3

Title:

The Effects of Integrating a Learning Strategy in CBI

Author:

Bruce R. Harris

The Effects of Integrating a Learning Strategy in CBI

Tutorial courseware allegedly enacts a dialog between the program designer and the learner. According to Soulier (1988), "dialog frames" present information to the learner, as well as carry out an interactive dialog/feedback between the learner and the computer. Soulier borrows the terminology of "dialog frames" from Alfred Bork (1980), who defined dialog as "a 'conversation' between a student and a teacher, where the student is at the computer display and the teacher is conducting the dialog through the medium of a computer program" (p. 15).

Soulier (1988) explains that dialog frames in computer-based instruction (CBI) usually have three parts: rules, examples and interactions. The information or subject matter is usually presented in the first two parts. The focus of this study is concerned with the third part, the practice component, or as Soulier refers to it, the interaction function.

According to Alessi and Trollip (1985), the most common method of CBI interaction is for the computer to pose questions the learner must answer. Questions serve a number of purposes. They keep the student attentive to the lesson, force the student to practice, and assess the student's recall and comprehension. In addition, student responses to the questions determine the sequencing for the remainder of the lesson.

Questions can be categorized into two basic types: selected-response and constructed-response. Selected-response questions are those for which the student chooses the correct response or responses from a list of two or more options. These include true/false, matching, multiple-choice, and marking. Multiple-choice items are the most common type of selected-response questions used in CBI (Alessi & Trollip, 1985). Constructed-response questions are open-ended questions that require the student to produce rather than select a response. The three major types of constructed-response questions are completion, short-answer, and essay. In CBI, the most common are completion and short-answer questions.

In a chapter of a recent book on designs for microcomputer courseware, Jonassen (1988) states that one of the problems with most tutorial courseware is that the level of mental processing required of learners is too shallow. He claims this weakness is due to the multiple-choice and short-answer questions predominantly used in CBI interactions. He states that the nature of the interactivity is usually recognition and recall of information presented on the previous screen, with little, if any, attempt to relate the information to prior knowledge, so that it will be meaningful and therefore retrievable by the learner. Jonassen (1988) states,

> Tutorial courseware is basically a mis-application of the programmed learning model of instructional design, which has been the dominant paradigm in the field of educational technology for nearly three decades. Since the programmed learning model is easily confused with the procedure or technique of programmed instruction, it is better conceptually defined by the mathemagenic hypothesis.
>
> Mathemagenic behaviors are "those student activities that are relevant to the achievement of specified instructional objectives in specified situations or places," that is, those which "give birth to learning" (Rothkopf, cited in Jonassen, 1988). These behaviors, according to the hypothesis, can be controlled or manipulated by specific design attributes of instruction. The form or structure of instruction or the activities stimulated by it induce the necessary cognitive operations to produce the desired learning. . . . The purpose of mathemagenic activities, such as inserted questions (the basis of programmed learning), is to control the way in which information is transformed and encoded into memory. It is therefore a reductive approach to learning, which

> regards learners as active performers whose mental behavior should be strictly controlled by the activities imposed by the lesson. (p. 152)

Jonassen continues by stating that one of the problems with computer applications of the mathemagenic model is that the level of processing normally produced by mathemagenic behaviors (especially programmed learning) is too low or shallow.

To solve the problem, Jonassen (1988) recommends tutorial courseware be developed based on a more constructive conception of learning, that is, instruction which focuses more on cognition, requiring deeper levels of mental processing.

In order to increase the level of mental processing, Jonassen (1988) recommends that tutorial courseware should enhance meaning of course information by stimulating the learners to call up and apply what they already know. He suggests that this deeper processing can be achieved by incorporating learning strategies into the courseware. These learning strategies sometimes referred to as cognitive strategies, are mental operations or procedures that represent a wide range of cognitive activities including underlining main ideas, generating examples or analogies, summarizing, outlining, etc., which the student may use to acquire, retain, and retrieve different kinds of knowledge (Rigney, 1978). They are designed to increase the number of "links" between presented information and existing knowledge in order to enhance retention and to allow the student to process information generatively (Wittrock, 1974). They are always performed by the learner--at the initiation of the student or the instructional system.

According to Weinstein and Mayer (1986), in recent years increased attention has been placed on the role of the learner as an active participant in the teaching-learning act. Many articles suggest that the effects of instruction depend partly on prior knowledge, and the learner's active cognitive processing during the learning process (Anderson, Spiro & Montague, 1977; Cook & Mayer, 1983; Dansereau, 1985; Jones, Amiran & Katims, 1985; Mayer, 1984; Ryan, 1981; Weinstein, 1978; Weinstein & Underwood, 1985; Wittrock, 1974, 1978). Wittrock's (1974) generative learning hypothesis assumes that when faced with instructional stimuli, learners construct and assign meaning to the stimuli on the basis of prior learning. The meaning generated by learners for information they receive is individual and cannot be controlled by the author. According to Wittrock (cited in Jonassen, 1988), learning is not "a passive reception of someone else's organizations and abstractions" (p. 153). Instead, learning is an active, constructive process. Jonassen (1985) states,

> The purpose of generative strategies is to provide learners with active, constructive skills for proactively transferring prior knowledge. Meaning (knowledge, if you prefer) is learner-constructed, not media-controlled. These [learning] strategies, such as paraphrasing, generating questions, and imaging, are all individual processes for constructing meaning. (p. 31)

Jonassen (1985) explains that microcomputers are especially amenable to the inclusion of learning strategies because they can accept, store, and manipulate a variety of input, and they can insist on a response before allowing the learner to proceed; something which traditional print media cannot do. For instance, after presenting the information, the computer system could direct the learner to go through a particular learning strategy, with the computer functioning as an "electronic notebook." The learner can key in a response which the computer evaluates for quantity or existence of key concepts and sometimes manipulates through rearranging or mapping and then stores for use by learners as a review or retrieval strategy. Jonassen (1988) believes that assessing user input will ensure higher levels of processing than the multi-option recognition or recall tasks included in most tutorial courseware.

Jonassen (1988) recommends that "the simplest method for integrating [learning] strategies in courseware is to replace the adjunct, mathemagenic activities that are normally included as practice in courseware with specific information processing or perhaps metalearning strategies" (p. 160). More specifically he suggests:

> For example, rather than inserting multiple-choice questions to test immediate recall or comprehension of information in a program, you might periodically insert any of the following directions: Summarize in your own words the ideas presented; recall and record key ideas and use them to create analogies, outlines, or cognitive maps; draw a picture or generate a mental image of the subject matter; or list the implications of the material that you are studying. (p. 160)

In discussing the rationale for replacing multiple-choice and short-answer questions in CBI interaction frames, Jonassen (1988) explains that "only deeper, semantic processing of information requires the learner to access prior knowledge in order to interpret new material" (p. 153). He makes the point that integrating cognitive strategies into CBI interactions will facilitate higher level learning outcomes, such as comprehension and understanding, and will also increase the amount of information that is recalled. Because learners assign more meaning to the information presented during the tutorial, they will be able to remember more. Jonassen continues,

> It is exactly this level of meaningful learning that is most frequently missing from tutorial types of courseware. The emphasis is on practice of associations in working memory based only on information recently presented in the courseware. In interacting with the tutorial courseware, learners are too seldom required to access prior knowledge in order to interpret the information that is presented. (p. 153)

The primary purpose of this study was to examine the effects of replacing multiple-choice questions in tutorial courseware practice interactions with a learning strategy (learner-generated summaries) on immediate recall. The study was designed to investigate empirically the approach recommended by Jonassen (1988) to integrate learning strategies by replacing the traditional multiple-choice questions in CBI interactions.

Although several studies within the last few years have investigated the effects of integrating individual learning strategies in instructional systems and developing instructional systems that train learners how to use a particular learning strategy (Weinstein & Mayer, 1985; Dansereau et al., 1979; O'Neil, 1978; O'Neil & Spielberger, 1979), the practice of integrating learning strategies in CBI interactions has not received much attention in the research literature. The few studies which have been conducted had a different focus than the present study. For example, these studies either dealt with a different learning outcome than immediate recall or the study tried to validate a different type of learning strategy (for example, see Eucker, 1984; Allen, 1982; Wilshire, 1990). The findings from these studies did not support the hypothesis that integrating a learning strategy in CBI would be more effective in facilitating learning than the traditional approach used by the comparison group(s).

Several studies have examined different aspects of student-generated summaries (Annis, 1985; Brown, Campione, & Day, 1981; Day, cited in Brown, Campione, & Day, 1981; Ballesteros, 1986); however, none have examined the specific effects of integrating this strategy in CBI interactions on immediate recall.

The following hypotheses and research questions were addressed in this study:

Hypotheses

1. Learner-generated summaries in tutorial courseware will be more effective in facilitating learners' ability to immediately recall information than multiple-choice interactions.
2. A system-generated summary provided to learners (as a form of feedback) after they generate their own summaries will be more effective in facilitating learners' ability to immediately recall information than not providing a system-generated summary.

Research Questions

1. Will students who are required to generate summaries take significantly more time to complete the intervention than students who respond to multiple-choice interactions?
2. Will students who are provided a system-generated summary type fewer words in their summaries than students who are not provided a system-generated summary?
3. Will typing rather than writing the learner-generated summaries affect the quantity or quality of the summaries?
4. To what degree will students use self-initiated learning strategies during the intervention?

Method

Subjects

Subjects were obtained from an undergraduate computer course (Computers in Education) offered in the College of Education at Brigham Young University in Provo, Utah. They were required to complete the intervention for this study as one of their assignments in the course. Thirty-five students participated in the study: thirty-two females and three males.

Materials

The intervention for all treatment groups consisted of an interactive videodisc tutorial on the subject matter of developmental biology, developed by WICAT Incorporated in 1979, under a grant from the National Science Foundation (Bunderson, Olsen & Baillio, 1981). The hardware consisted of a Macintosh-based interactive videodisc system.

The instruction, which was developed for university-level students, dealt primarily with verbal information learning outcomes. This explanative material (Mayer, 1989) consisted of an introduction to basic developmental biology concepts such as DNA, RNA, genes, chromosomes, etc. It was selected for several reasons. First, the researcher believed that most students had very little prior knowledge about the content, which was desirable in determining whether a learning effect occurred as a result of the treatment. Second, the instruction on the videodisc had been developed using the traditional type of CBI interactions: an instructional segment followed by multiple-choice questions. Finally, since the content area was not related to the course in which students were enrolled, the researcher believed the students would not make extensive use of self-initiated learning strategies as they completed the instruction.

The interaction frames and the courseware that controlled the videodisc were developed on the computer by use of the authoring program *The Best of Course of Action*, developed by Authorware, Incorporated (Authorware, 1987).

Research Design

The research was conducted using a Pretest-Posttest Comparison Group Design. The students were randomly assigned to one of three treatment groups. The instruction delivered during the intervention was the same for all three treatment groups--four modules consisting of videodisc motion sequences and several still frames concerning developmental biology. Students in Group 1 answered multiple-choice questions after each instructional module. In Group 2, students were asked to generate a written summary, which they typed in their own words on the computer, about the information presented in each module. Students in Group 3 were also asked to type a written summary of the information just presented to them; however, after they wrote their summary, they were provided feedback in the form of a system-generated summary which summarized all of the main points in the module and were told to compare the system-generated summary with their own to determine if they had left out any important ideas.

The independent variable was the type of learner response required during the CBI interaction following the instructional modules. The dependent variable for the hypotheses was the posttest score.

Instruments

A pretest was developed to assess the preexisting knowledge of students on the content of developmental biology in order to determine if the three treatment groups were equivalent as a result of random assignment to groups. A posttest was developed using items selected from a posttest developed by WICAT Inc., based on the information presented in the videodisc. The test consisted of multiple-choice, matching, true/false, and short-answer test items which assessed recall learning outcomes.

Internal consistency reliability measures were computed on the test scores to assess the reliability of the results. The reliability (Cronbach Alpha) coefficients for the pretest and posttest scores were .76 and .72, respectively.

Procedure

The researcher administered the intervention for each student individually during a one-hour time slot. When the student arrived, the researcher briefly explained the nature of the study and then requested him or her to sign a participation consent form and complete the pretest. The researcher then gave the student a brief overview on how to use the instructional system.

After the orientation, the students were presented a module of instruction consisting of several still frames and a motion sequence. The students were then asked to either answer multiple-choice questions or generate a summary of the information just presented. Students in Group 1 who selected the correct answer were given a short statement affirming the correct selection. Students who selected the wrong answer were told their answer was incorrect and then given the correct answer. Students in Group 2 were asked to generate a summary of the material just presented. After the student typed his or her summary, the instructional system presented the next module. Students in Group 3 were given the same instructions as those in Group 2; however, immediately after the students typed their summary, the system presented a complete summary of all the main ideas presented as a form of feedback. Students were asked to compare their summaries to the system-generated summary to determine if they had left out any important information or concepts. This pattern continued for the remaining three modules. Students in Group 1 answered a total of 20 multiple-choice practice items, and students in Groups 2 and 3 generated four summaries during the entire intervention.

After the students completed the intervention, they took the posttest. Students took an average of 60 minutes to complete the entire process.

Data Analysis

The hypotheses were analyzed using a planned, orthogonal comparison statistical design. Information related to the first two research questions (minutes of elapsed time and average number of words written in the learner-generated summaries groups) was analyzed for the three treatment groups using one-way analysis of variance. The last two research questions were analyzed using descriptive statistics.

Results

Of the 35 subjects, 12 were in Group 1, which answered multiple-choice questions, 11 were in Group 2 which generated summaries without feedback, and 12 were in Group 3 which generated summaries and received feedback. Means, standard deviations, and ranges were computed on (a) the number of correct answers on the pretest (20 points possible), (b) number of correct answers on the posttest (33 points possible), (c) instructional time, and (d) number of words in student-generated summaries (for Groups 2 and 3 only). Table 1 summarizes these computations.

Table 1

Group Means, Standard Deviations, and Ranges for Pretest Scores, Posttest Scores, Instructional Time, and Number of Words in Student-Generated Summaries

Treatment Group	Pretest Scores	Posttest Scores	Instructional Time (minutes)	Number of Words in Summaries
Group 1 (Multiple-choice items)				
Mean	8.3	24.3	25.0	NA
SD	3.1	2.5	5.1	NA
Range	2-12	18-28	19-33	NA
Group 2 (Student-generated summaries without feedback)				
Mean	8.2	23.2	35.6	205.0
SD	4.6	3.7	12.0	74.2
Range	1-14	17-28	20-64	87-344
Group 3 (Student-generated summaries with feedback)				
Mean	8.9	24.0	34.9	236.2
SD	4.2	4.1	8.5	116.6
Range	2-15	16-30	17-53	77-504

One-way analysis of variance revealed that the differences between means on the pretest scores were not statistically significant, indicating that the three groups were equivalent in preexisting knowledge about the material presented in the instruction, F (2, 32) = .11, p = .896.

The first hypothesis (learner-generated summaries groups will score higher than the multiple-choice group) was tested using a complex, orthogonal, planned comparison analysis (Keppel & Zedeck, 1989), in which the average of the means for the two learner-generated summaries groups (Groups 2 & 3) was compared with the mean of the multiple-choice practice group (Group 1). Results from the analysis indicated no significant treatment effects, T (32) = .53, p = .60.

The second hypothesis (Group 3 will score higher than Group 2) was tested using a pairwise, orthogonal, planned comparison analysis, in which the mean of the learner-generated summaries without feedback group (Group 2) was compared with the mean of the learner-generated summaries with feedback group (Group 3). Results from the analysis indicated no significant differences between the two groups, T (32) = .57, p = .58.

With regard to the question of instructional time, Table 1 shows that students in Group 1 spent an average of 10 minutes less than students in Groups 2 and 3 during the instruction. One-way analysis of variance resulted in a significant difference between the means of the treatment groups, F (2,32) = 5.3, p = .01. Results of a Tukey-HSD post hoc comparison analysis (p < .05) indicated that Groups 2 and 3 differed significantly from Group 1.

The second research question sought to determine if there was a significant difference in the number of words generated by the students in Group 2 and Group 3, based on the concern that students in Group 3 might minimize the words they wrote in their self-generated summaries as a result of knowing they would be presented a system-generated summary after typing in their summary. Table 1 shows that Group 3 generated an average of 30 more words than students in Group 2. A one-way analysis of variance showed that the difference between means was not statistically significant, F (1, 21) = .572, p = .458.

The third research question examined whether typing rather than writing affected the quality of the students' summaries. To answer this question, the researcher asked students who generated their own summaries if they felt typing versus writing their summaries affected the quality and quantity of those summaries. Of the 23 students who responded, three students indicated that they would have written more and their summaries might have been of a higher quality had they been allowed to write the summaries on a piece of paper. All other students indicated that typing was not a factor in generating their summaries. Twenty students said they would prefer to type their summaries if given a choice, whereas three students indicated they would prefer to write their summaries.

The fourth research question was critical to the final study: If students used extensive self-initiated learning strategies in addition to those designed in the interventions, the results would perhaps be influenced more by learner variance than by treatment variance. The students were interviewed and asked what self-initiated learning strategies, if any, they used as they progressed through the instruction. The results as summarized in Table 2, show that 66 percent of the students used rehearsal strategies which consist of repeating more than once in their minds the material presented to them. However, as Table 2 shows, few students used any learning strategies other than the rehearsal technique strategies.

Table 2

Self-initiated Learning Strategies Used by Students

Response Categories	Number of Respondents	Percentage of Respondents
Rehearsal	23	66%
Organizational Strategy	8	23%
Mnemonics	7	20%
Mental Imagery	3	9%
Note Taking	2	6%

Note: These percentages do not add up to 100 percent because students could give more than one response.

Discussion

The results of this study did not support the first hypothesis: replacing multiple-choice questions with learner-generated summaries in tutorial courseware did not result in learners recalling significantly more of the information presented during the instruction. In addition, the results show that students in the learner-generated summary groups took significantly more time to complete the intervention than students in the multiple-choice questions group.

It was also hypothesized that providing a system-generated summary to learners after they generated their own summary would be more effective in facilitating learners' ability to immediately recall information than not providing a system-generated summary. The results did not support this hypothesis.

What are some of the theoretical implications of these findings? First, because of the small number of subjects in each group, learner variance could have had a significant influence on the results. The researcher plans to continue this line of research with a larger sample size. Second, for the particular recall learning outcome assessed in this study, students may need the practice items of multiple-choice questions to provide the necessary repetition required for immediate recall (Gagne, 1985; Gagne, Briggs & Wager, 1988). Third, the multiple-choice response items may have highlighted the key knowledge elements presented in the instruction which focused the learners' attention on the information that was really important. Fourth, another theoretical issue which may have had some influence on the results of this study is the degree of instructional alignment between the learning strategy and the learning outcomes (Cohen, 1987). Perhaps using learner-generated summaries was not the most appropriate strategy to use for the particular learning outcome measured. Learner-generated summaries may have facilitated other higher-level learning outcomes that were not measured in this study, such as understanding, transfer, synthesis, etc. Finally, another possible explanation which may have influenced the results of this study was the degree to which students wrote effective summaries. Perhaps the subjects in this study were much more familiar with responding to short-answer and multiple-choice items and hadn't received much practice in writing summaries.

The results of this study show that replacing multiple-choice questions in tutorial courseware with learner-generated summaries does not facilitate the specific learning outcome of immediate recall for the specific material used in this study. In fact, replacing multiple-choice questions with learner-generated summaries in CBI interactions reduced the efficiency of the learning process, since students who generated their own summaries took significantly longer to complete the instruction.

References

Alessi, S. M., & Trollip, S. R. (1985). *Computer-based instruction: Methods and development*. Englewood Cliffs, New Jersey: Prentice-Hall.

Allen, B. S. (1982). The effects of system-assigned learning strategies and hierarchical displays on acquisition of coordinate concepts: An exploratory study utilizing a computer-based research tool. Unpublished doctoral dissertation, University of Southern California.

Anderson, R. C., Spiro, R. J., & Montague, W. E. (Eds.). (1977). *Schooling and the acquisition of knowledge*. Hillsdale, N.J.: Erlbaum.

Annis, L. F. (1985). Student-generated paragraph summaries and the information-processing theory of prose learning. *The Journal of Experimental Education, 54* (1), 4-10.

Authorware. (1987). Course of Action Reference Manual. Minneapolis, Minnesota: Author.

Ballesteros, H. M. (1986). *Effects of learner-generated paragraph outline on learning from text.* Unpublished doctoral dissertation, Southern Illinois University at Carbondale.

Bork, A. (1980). Preparing student computer dialogs: Advice to teachers. In R. P. Taylor (Ed.), *The computer in the school: Tutor, Tool, Tutee* (pp. 15-52). New York: Teachers College Press.

Brown, A. L., Campione, J. C., & Day, J. D. (1981). Learning to learn: On training students to learn from texts. *Educational Researcher, 10* (2), 14-21.

Bunderson, C. V., Olsen, J. B., & Baillio, B. (1981). Final Report: Proof-of-concept demonstration of a prototype intelligent videodisc system. Provo, Utah: WICAT, Inc.

Cook, L. K., & Mayer, R. E. (1983). Reading strategy training for meaningful learning from prose. In M. Pressley & J. Levin (Eds.), *Cognitive strategy training*. New York: Springer-Verlag.

Cohen, S. A. (1987). Instructional Alignment: Searching for a magic bullet. *Educational Researcher, 16* (8), 16-20.

Dansereau, D. F. (1985). Learning strategy research. In J. Segal, S. Chipman, & R. Glaser (Eds.), *Thinking and learning skills, Vol. 1: Relating instruction to research*. Hillsdale, N. J.: Erlbaum.

Dansereau D. F., McDonald, B. A., Collins, K. W., Garland, J., Holley, C. D., Diekhoff, G. M., & Evans, S. H. (1979). Evaluation of a learning strategy system. In H. F. O'Neil & C. D. Spielberger (Eds.), *Cognitive and affective learning strategies*. New York: Academic Press.

Eucker, T. R. (1984). System assignment of learning strategies in a computer simulation of an imaginary science. Unpublished doctoral dissertation, University of Southern California.

Gagne, R. M. (1985). *The conditions of learning and the theory of instruction* (4th ed.). New York: Holt, Rinehart and Winston.

Gagne, R. M., Briggs, L. J., & Wager, W. W. (1988). *Principles of Instructional Design*. New York: Holt, Rinehart and Winston.

Jonassen, D. H. (1985). Learning strategies: A new educational technology. *Programmed Learning and Educational Technology, 22* (1), 26-34.

Jonassen, D. H. (1988). Integrating learning strategies into courseware to facilitate deeper processing. In D. H. Jonassen (Ed.), *Instructional designs for microcomputer courseware* (pp. 151-181). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Jones, B. F., Amiran, M. R., & Katims, M. (1985). School applications of the mnemonic keyword method as a study strategy by eighth graders. *Journal of Educational Psychology, 74* (2), 230-237.

Keppel, G., & Zedeck, S. (1989). *Data analysis for research designs*. New York: W. H. Freeman and Company.

Mayer, R. E. (1984). Aids to prose comprehension. *Educational Psychologist, 19*, 30-42.

Mayer, R. E. (1989). Models for understanding. *Review of Educational Research, 59* (1), 43-64.

O'Neil, H. F. (Ed.). (1978). *Learning strategies*. New York: Academic Press.

O'Neil, H. F., & Spielberger, C. D. (Eds.). (1979). *Cognitive and affective learning strategies*. New York: Academic Press.

Rigney, J. (1978). Learning strategies: A theoretical perspective. In H. F. O'Neil (Ed.), *Learning strategies*. New York: Academic Press.

Ryan, E. B. (1981). Identifying and remediating failures in reading comprehension: Toward an instructional approach for poor comprehension. In T. G. Waller & G. E. MacKinnon (Eds.), *Advances in reading research*. New York: Academic Press.

Soulier, J. S. (1988). *The design and development of computer based instruction*. Boston: Allyn and Bacon.

Weinstein, C. E. (1978). Teaching cognitive elaboration learning strategies. In H. F. O'Neil, Jr. (Ed.), *Learning strategies*. New York: Academic Press.

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd Ed.), New York: Macmillan.

Weinstein, C. E., & Underwood, V. L. (1985). Learning strategies: The how of learning. In J. Segal, S. Chipman, & R. Glaser (Eds.), *Thinking and learning skills, Vol. 1: Relating instruction to research*. Hillsdale, N. J.: Erlbaum.

Wilshire, D. T. (1990, February). Effectiveness and efficiency of elaboration using CAI. Paper presented at the annual meeting of the Association for Educational Communications and Technology.

Wittrock, M. C. (1974). Learning as a generative activity. *Educational Psychologist, 11*, 87-95.

Wittrock, M. C. (1978). The cognitive movement in instruction. *Educational Psychologist, 13*, 15-29.

Title:

Learners' and Instructor's Roles in the Learning Environment

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Learners' and Instructors' Roles
in the
Learning Environment

Duncan Harris

Introduction

The other two contributors are focusing on the physical facilities of the environment. I would like to look at the human aspects of the environment. Obviously learning styles are an important aspect, but I would suggest that the roles of teachers and learners are the key issues not learning styles. In the limited time I am missing out the more global institutional and organisational factors which are also key factors. I shall concentrate on the learning environment.

In the learning environment learners and instructors will have certain expectations of their roles from previous experience. So, for example, learners in an armed services environment may be used to a passive role, with the instructors perceived not only as the experts but also the controllers of discipline.

I would like to explore a simple idea of the potential roles of learners and instructors as they affect the learning environment.

Learners Roles

The focus is roles, although there is a relationship with learning styles and approaches. Learning can occur in any combination of skills, cognitive learning, attitudes and cooperation (ie inter-personal skills). I would like to look at four roles of learners (Harris and Bell, 1990)

Receiver

Detective

Generator

Facilitator

The learner as RECEIVER may be: listening to somebody talking (it could be the instructor, another learner), watching somebody performing a skill, observing the behaviour of a person in a group. The role is generally a silent role and is a clear expectation in a didactic learning environment. (It has some relationship to declarative learning, Rumelhart and Norman, 1981)

The learner as DETECTIVE has a problem to solve, the solution may not be part of the detective role. That problem could be: how to enable a member of a group to play a more active part in the group, how to go about the manipulation of a piece of wood to bring about a particular shape with a particular set of machines and tools, how to solve a new mathematical problem. The role is a more active role, where there is an expectation for the learner to take some responsibility for the learning. A different learning environment will be needed to enable this to occur. The learner has to be aware of the different expectations. (It is related to procedural learning, Rumelhart and Norman, 1981).

The learner as GENERATOR is trying to be creative, developing new ideas, new relationships, new skills. It is a role with even more responsibility. A role often excluded in many courses in higher education where credits can be obtained for repeating what was received. (It is associated with generative learning, Wittrock, 1974).

The learner as FACILITATOR is probably the most advanced role where the learner is about enabling other learners to succeed. The facilitation can occur in skills, cognitive learning, it can occur more obviously in cooperative learning. So often cooperative learning is assumed as an existing skill (for example asking learners to work together at a computer terminal), yet the role of learners need to be changed to that of facilitator to enable cooperative learning (see, for example, Slavin, 1983).

I would suggest to you that the designer not only has to be aware of the design expectations of learners' roles, but also what learners expectations are in the context of learning. If the learner expects to play the receiver role, then designing for the facilitator role has potential mismatches with the existing learning environment. There can also be constraints dictated by the learning environment: the strategy, materials, equipment may necessitate certain roles.

Instructors' Roles

Again the focus is on roles, this time for Instructors. I find a musical analogue useful in this context (Harris, 1979). The four roles are:

Performer

Conductor

Composer

Critic

Let us explore these roles in more detail. The PERFORMER is the didactic presenter (my current role), although I can play the role in the written word, at a piece of equipment or manipulating a group! However the last is perhaps not part of this role!

The CONDUCTOR role is the instructor who is helping a group of learners who may all be doing different learning activities at the same time. The conductor ensures that all the learners have help as needed and also takes them on to new learning activities as necessary. The learning activities can be anything from maths through science experiments to drama rehearsals. The design for the learning activity is very dependent on the role of the instructor.

The COMPOSER is more obvious as the designer of the learning, usually for that group of learners or only those groups with whom the instructor comes into contact. I suppose the ultimate composer is the designer of curricular resources which will be used in any institutions perhaps across states, but I have restricted the role to those who are mainly instructors. Obviously if there is a learning environment where the instructors are used to the role of composer then it is important for designers to incorporate some part of this role in the design.

The CRITIC role is that of the evaluator of learners' work, of the learning process.

Expectations

There are expectations from learners and from instructors in any learning environment. Returning to the example from the armed services, the expectations of the learners and of the instructors would be for the learners to take the receiver role and for the instructors to take the performer role. Any learning design which changes these expectations needs careful incorporation of enabling the instructors and learners to take up new roles. It is insufficient to just present a total change in the expectations of roles. It will be necessary to provide assistance to the instructors for the new role and also for the learners for the new role. Designers need to incorporate such resources, guidance and assistance to enable the new approach to be taken on with a gradual gain in confidence rather than a step function change. The intention of any design is to enable commitment from the instructors and the learners to the new approach. That commitment an only occur when there is a deliberate effort in the design to help the learners and the instructors.

The three key issues (Tessmer and Harris, 1992) that arise are

Mismatches

Attitudes

Communicability

The idea of MISMATCHES has already been identified in the previous paragraph. If there are mismatches in the expectations of the instructors and learners, then it is unlikely that the design will be effective in the learning environment. Mismatches for instructors are probably more influential in providing a barrier to the implementation of the design. Mismatches with learners may present ineffective learning unless there is considerable commitment from the instructors.

The ATTITUDES of instructor and learners are the crucial aspects which will enable or prevent successful outcomes from the design. The designer is always looking for commitment from instructors and learners, but there is also a need to enable the commitment by careful incorporation of persuasion and development during the actual learning process (learning for both instructor and the learners about the changed expectations).

In order to enable the change in attitudes the design must incorporate COMMUNICABILITY. There is little point in having a carefully designed guide for instructors which puts them off at the first stage...many of us will be familiar with early (and more recent) manuals for computer software which make unreasonable assumptions about the knowledge of the user. It is essential that there is a clear communication to the instructors and the learners.

Conclusion

The learning environment is dependent on the roles of the learners and of the instructors. The design needs to take account of the current expectations of the learners in their own environment (Harris and Tessmer, 1990). If there is to be a change in role for the instructors and/or the learners then the design needs to enable the instructors and the learners to become accustomed to those roles (You may find the list of questions in Appendix A helpful during design processes). Unless there is a commitment to the approach there is likely to be a poor reception for the new approaches and resources. Not only does there need to be a commitment from the instructors and the learners but also from the organisation and the institution,....but that is another story!.

References

Harris N D C (1979) **Preparing Educational Materials** London, Croom Helm.

Harris D, Bell C (1990) **Evaluating and Assessing for Learning** London, Kogan Page.

Harris N D C, Tessmer M A (1990) Environmental Analysis: How do You Catch the Learner? **Educational and Training Technology, 27,** 4, 350-364.

Rumelhart D E, Norman D A (1981) Analogical processes in learning in Anderson J R (Ed) **Cognitive Skills and their Acquisition** Hillsdale NJ, Lawrence Erlbaum Associates.

Slavin R E (1983) **Cooperative Learning** New York, Longman.

Tessmer M, Harris D (1992) **Analysing the Instructional Setting: Environmental Analysis** London, Kogan Page.

Wittrock M C (1974) Learning as a generative activity **Educational Psychologist, 11,** 87-95.

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Appendix A

QUESTIONS FOR THE DESIGNER RELATING TO THE ROLES OF THE INSTRUCTORS AND OF THE LEARNERS. (Tessmer & Harris, 1992)

- What are the expectations from the learners in the learning environment?
  - How are they expected to do the learning?
  - When are they expected to do the learning?
  - What responsibilities are they expected to take?
- Can the learning environment support variations in the learners' role?
  - Why are the learners doing the learning?
  - What do they expect to learn?
  - How do they expect to learn?
  - Where do they expect to do the learning?
  - What responsibilities do they expect to take?
- What are the expectations from the instructor in the learning environment?
  - How are instructors expected to help learners?
  - When are instructors expected to help learners?
  - What is the division of responsibility between the instructors and the learners?
- Can the learning environment support variations in the instructors' role?
  - What expectations do instructors have from their contract of employment?
  - What contact do instructors have with learners?
  - What responsibilities are instructors expected to give to learners?
  - What role would instructors prefer to play?

The answers to these questions will determine the design of the learning. By using explicit statements of these expectations the designer has a key framework as a basis for the design. The learners may wish to choose between alternatives where they have the teaching done ON them, the teaching done WITH them or the teaching done BY them. If the learners expect to go to a course where everything is done for them and find that they are expected to work in self motivated syndicates negotiating their own goals etc, they may feel cheated relative to their expectations. To prevent this, it is essential that the designer collects information to enable the decisions to meet the expectations of the instructors and learners or to identify the needs for communication or persuasion to make the innovation feasible. To collect this information the designer should keep the following principles in mind:

- *Site visits are essential.*
- *For young learners talk with them to find out what they say that they like.*

- *For older learners use group techniques (eg snowball technique).*
- *For instructors the snowball technique is also applicable.*
- *Surveys of learner and instructor opinions can be used to generalise the data from the group techniques.*
- *Observation of the current practices of instructors and learners will provide further evidence and ensure triangulation.*

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Title:

Effects of Instructional Design with Mental Model Analysis on Learning

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Abstract

This paper discusses the need for integrating mental model analysis in the process of instructional program development. Investigations into the effects of mental models strategy have indicated positive effects on learning and instruction. It was proposed that in developing instructional materials which require complex cognitive process in learning, the instructional designer identify the integrative goals/objectives along with their component declarative and procedural knowledge, and develop instructional strategies that can help learners acquire integrated outcomes such as relevant mental models in the specific domain. The procedures and examples of the instructional materials development with mental model analysis are illustrated.

Effects of Instructional Design with Mental Model Analysis on Learning

The concept of mental models (Wilson & Rutherford, 1989; Norman, 1986) has recently been introduced to the field of instructional psychology along with other constructs of knowledge representation such as schemata (Rumelhart, 1980), frames (Minsky, 1975), or scripts (Schank & Abelson, 1977). Investigations into the effects of mental models strategy in relation to learning and instruction have been conducted in various domains (Dyck & Mayer, 1989; Gentner & Stevens, 1983; Mayer, 1989; Kieras, 1987; White & Frederiksen, 1986). Mayer, Dyck, and Cook (1984), for example, investigated the effects of mental models on performance in causal systems. They provided node training which is the conceptual underpinnings of the key definitions involved in the passage, and link training provided by passages that emphasized the main relations among concepts. They predicted that subjects who were provided with the mental models aids would build a coherent mental model of the system. Compared to the control group, the mental model group significantly recalled more information concerning the main concepts and their relationships, and performed better in creative problem solving.

In a study by Kieras and Bovair (1984), subjects who knew how a control device worked could learn and infer how to operate it much more efficiently than subjects who did not have this information. In their experiment, the mental model group, who were exposed to the device model that describes the internal mechanism of the device before receiving the procedure training on how to operate a control device, learned the procedures faster, retained the procedures more accurately, and executed the procedures faster than the rote group. These results support instructional strategies that help learners build mental models, which will, in turn, promote subsequent learning and problem solving.

Streitz (1988) distinguished a mental model from a conceptual model in that a mental model is a subjective knowledge representation that is an idiosyncratic and very personal model, while a conceptual model is a model developed by scientists or designers. In studies of instructional applications of mental models, Mayer

(1989) concluded that by using conceptual models, which are words and/or diagrams that are intended to help learners build mental models of the system being studied, learners could improve their recall of conceptual information and increase their creative solutions on transfer problems.

In the present study, the author reserves the term mental model for a person's internal, domain-specific representation which may be incomplete or unstable, and the term relevant mental model for an internal, domain-specific representation that is relevant and useful for a person's subsequent understanding and in problem solving in the domain.

This paper presents a model for systematic instructional design that includes mental model analysis, and the procedures used in developing computer-based instructional materials in the area of statistical hypothesis testing. The instructional design model is based on the premise that the objective of learning is to achieve expert-like mental models, and instruction should be designed to help learners build relevant mental models in the specific domain. In addition, the instructional effects which resulted from the application of the mental model strategies in the domain of introductory hypothesis testing are discussed.

A Model for Instructional Systems Design with Mental Model Analysis

The quality of an instructional system would be considered high when adequate contents are presented to learners using proper instructional strategies. In a recent discussion on integrative goals for instructional design, Gagné and Merrill (1990) suggested the integration of multiple objectives for comprehensive purposeful activities. They considered integrated objectives as an enterprise, and proposed that integrative goals be represented in cognitive space by enterprise schemas (similar to the concept of mental models) whose focal integrating concept is the integrative goals.

As Gagné and Merrill (1990) suggested that instructional design must specify the conditions for acquisition of enterprise schemas or mental models, the content/task analysis which emphasizes on mental models are expected to lead to considerable changes in instructional strategies and material development. Thus, the author proposes that mental model analysis be integrated as one of the phases in the systematic design of instructional materials so that cognitive task analysis can produce instructional strategies, which provide conditions for learners to build relevant mental models in the domain.

Phases of Systematic Design of Instructional Materials

The model described in this paper is categorized into three phases in a systematic design of instruction: (1) analysis of instructional outcomes, (2) development of instructional material, and (3) implementation, evaluation, and revision of the instructional material.

Phase I: Analysis of instructional outcomes. In this phase, information about the resulting outcomes are to be provided. After the overall instructional goals are identified, relevant mental models for the domain will be determined through cognitive task analysis (i.e., mental model analysis). The mental model analysis identifies declarative and procedural knowledge involved in the domain, and determines whether mental model strategies would be helpful in the particular domain. The end results of this phase would be the determination of the relevant mental models for teaching learners.

Phase II: Development of instructional material. To ensure optimum learning, learners' entry level knowledge and skills are first identified in this phase. Using the information on the learners' entry level and the relevant mental models for teaching novices, instructional strategies to help learners build relevant mental models of the domain will be developed. Employing both macro and micro levels of instructional design strategies (Reigeluth, 1983), as well as the mental model strategies developed in this phase, instructional materials are developed along with the selection of appropriate media to deliver the instruction. Methods for assessing the learners' performance are also developed. In other words, whether learners acquired relevant mental models or not should be measured through appropriate assessment procedures.

Phase III: Implementation, evaluation, and revision of the instructional material. In this phase, the instructional materials developed in phase II are implemented for evaluation. The effectiveness and practical feasibility of the instruction are to be revealed through the formative evaluations (Dick & Carey, 1985), and necessary revisions should be made according to evidence from the evaluation. In the following section, each step of the model for the systematic design of instructional material is described.

Procedures for Developing Instructional Materials

Figure 1 presents a model of systematic approach to instructional materials development. In this paper, the emphasis is given on the application of mental model analysis to each step in describing the procedures for instructional materials development.

Insert Figure 1 about here

1. Identify instructional goals/objectives

Goals may be stated as the intended outcomes of instruction. In specifying learning outcomes, Gagné, Briggs, & Wager (1988) suggested that assigning learning objectives to five major categories of human capabilities (i.e., intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes) can simplify the instructional planning. However, in situations where complex cognitive processes are involved in learning, that is, when instruction involves more than simple rules/procedures or facts, instructional objectives may be specified comprehensively so that the following content/task analysis can be conducted to provide learning conditions for comprehensive activities. For instance, in developing instructional materials for teaching introductory hypothesis testing, an example of instructional objectives would be: The students will be able to make inferences about the nature of the population when given problems in hypothesis testing, through specifying null and alternative hypotheses, setting the region of rejection, computing the test statistic, making decisions about the hypotheses, and drawing valid interpretations on the decision made.

This example of an objective indicates that to achieve a higher level of performance in problem solving in this subject matter, the students should have both conceptual and procedural knowledge involved in hypothesis testing, and apply or synthesize that knowledge when they encounter problem-solving situations.

Instructional designers, then, may consider the objectives as coherent cognitive structures of integrated knowledge/skills of the to-be-learned materials, so that the following steps in the design of instruction would focus on the learners' outcomes which are goal-related knowledge and skills, or stated differently, coherent and relevant mental models of the particular domain.

Then, what and how should the specific knowledge or skills be presented to help learners develop the relevant mental models? This question calls for the analysis of mental models in the domain, which is the topic of the next section.

2. Conduct mental model analysis.

The purpose of mental model analysis is to determine relevant mental models for teaching learners in accordance with the instructional objectives specified in step 1. By examining both experts' and less-than-experts' mental models, relevant mental models learners should acquire as well as learners' common misconceptions in the domain will be determined. Figure 2 presents the procedure involved in conducting mental model analysis.

Insert Figure 2 about here

Determining if the mental model strategy can be helpful. To determine if the mental model strategy would help students learn materials in a particular domain, available texts or documents would first be analyzed to specify what knowledge/skills should be taught. In addition, subject matter experts may play a significant role in content/task analysis. Through the content analysis, declarative and procedural knowledge (i.e., facts, concepts, procedures, rules, or principles) involved in the domain are identified. The result of content analysis may reveal that the particular domain to teach involves, for example, concepts and principles, or it may involve only facts and simple procedures.

Upon the identification of knowledge/skills to be taught, it may be decided whether mental model strategy is helpful in teaching the particular domain. Kieras (1988) identified the situations when mental models are not useful in the domain of device maintenance: (1) if the procedures are easy to learn by rote; (2) if the device is so simple that the learner does not need to make inferences; (3) if mental models are too difficult or complicated for the learner to acquire and use; and (4) if mental models fail to support the inferences that the learner needs to make, or alternatively, support inferences that the learner does not need to make. In his review on the effects of conceptual models that are intended to help learners build mental models, Mayer (1989) focused on reviewing explanative material. Explanative material allows learners to build and use models that explain the information. Mayer (1989) added that the reason he focused on explanative material in his review was because meaningful methods of instruction can only have an effect for learning of material that is potentially meaningful.

Thus, to determine if mental model strategy is helpful, it should be analyzed to find out if the content requires meaningful learning or inferencing process based on knowledge acquired from the instruction. The designer may analyze if the mental model strategy would help learners in selecting information to pay attention to, in organizing incoming information in short-term memory, in integrating prior knowledge from long-term memory with incoming information, and in encoding the resultant learning outcome in long-term memory (Mayer, 1989).

In the domain of introductory hypothesis testing, existing textbooks were first analyzed. The declarative and procedural knowledge involved in hypothesis testing were identified, which were concepts, principles, and procedures involved in hypothesis testing. At this stage, it seemed that there could be a small set of mental models which could be either relevant or incorrect after students are exposed to problems on hypothesis testing.

Relevant mental models to teach. To determine relevant mental models to teach in introductory hypothesis testing, a pilot study was conducted. The procedures included: (1) experts' and intermediates' mental models were elicited; (2) the elicited mental models were compared with the textbook contents analyzed; and (3) the relevant mental model to teach novices were determined. This pilot study is described in detail elsewhere (Hong, 1990).

The results of the pilot study revealed that experts' verbal protocols on the problem solving process were incomplete such that their protocol indicates combined inference steps. This is largely because their knowledge were compiled through their extended learning process and extensive practice in problem-solving activities. However, in considering the learnability of expert models, several additional questions were presented to experts in order to decompile their knowledge, such as, "If you teach students to solve this problem, what would you do?" In investigating the intermediates' mental models, it was found that their mental models were especially useful in designing instruction because their knowledge was not compiled and their common misconceptions were revealed.

The major difference between experts and intermediates in the domain of introductory hypothesis testing was their conceptual understanding: While all experts had a solid conceptual understanding, many intermediates did not. However, the diagrammatic problem representation was useful for most subjects' problem solving, especially for intermediates. Considering the importance of conceptual understanding and usefulness of diagrammatic representation, the mental model to teach novices in the context of introductory hypothesis testing was defined as concepts and rules involved in hypothesis testing in diagrammatic representation.

Research on text illustration supports the use of diagrammatic representation in teaching or learning the instructional materials and solving problems: Students who received instruction such as text passages which include illustrations retained more information than those who received instruction without illustrations (Alesandrini, 1984; Anglin & Stevens, 1986; Curtis, 1988; Reid & Beveridge, 1986; Rusted & Hodgson, 1985). Studies on topologies of device models (de Kleer & Brown, 1983; Kieras, 1984), which used diagrammatic representations of the models, also show the effects of the diagrammatic presentation of the instruction.

3. Identify the learners' entry level knowledge/skills.

The most common method for assessing prerequisite knowledge and skills may be administering a pretest to students. The test may contain items to assess the knowledge and skills students should have when the instructor begins to teach new information (Dick & Reiser, 1989).

In the present hypothesis testing study, prerequisite knowledge/skills that a student should have were identified, and it was decided that a prerequisite learning and test session be provided. The intention underlying the test item development was that the subjects learn the prerequisites by solving problems and reading the informative feedback. The subjects were given the opportunities of answering twice in case they made incorrect responses. Informative feedback was given whether the response was correct or not.

4. Develop instructional strategies considering mental models.

To determine the instructional strategies to help learners build relevant mental models in hypothesis testing, the investigator designed four instructional units about the hypothesis testing for one-sample case for the mean (variance known). The four instructional units basically contained the same information, but were designed in different presentation sequences (separate and combined) and presentation modes (diagrammatic and descriptive). Briefly, the sequencing of the two instructional units, separate-diagrammatic and separate-descriptive units, were the same in that concepts involved in hypothesis testing were presented first, and then followed by procedural and quantitative instruction. For the combined-diagrammatic and combined-descriptive units, the concepts and procedures were presented simultaneously.

The primary difference between the diagrammatic and descriptive presentation modes was the frequency of the diagrams presented in the instructional units. In the diagrammatic presentation mode, 18 diagrams were presented, while six diagrams were presented for descriptive mode (see Hong & O'Neil, in press, for detail).

The rationale underlying the development of the four units were from the mental model analysis conducted in the earlier stage and the mental model literatures. Discussing the progressions of qualitative models in circuit behavior, White and Frederiksen (1986) advocated that qualitative conception of the domain should be acquired before quantitative models be introduced so that the causal relations in the domain could be obvious. They argue for the importance of presenting, in the initial stages of learning, qualitative, causally consistent models so that students can gain an understanding of basic concepts and principles.

In their study on transfer of computer language comprehensive skill, Dyck and Mayer (1989) conducted a cognitive analysis of BASIC languages. Then they provided sequential and simultaneous instructional methods. In the simultaneous method, the semantics of a language were taught within the syntax of the language, and in the sequential method, the semantics of a language were taught prior to the syntax of the language so that learning of semantic of a language can influence learning of the other language. Results supported the use of a sequential method of programming language instruction, because subjects who had previous experience in the learning of English procedural language (semantics) learned BASIC faster and more accurately.

These studies illustrates that the teaching of concepts prior to procedural/quantitative instruction may help students build relevant mental models. In addition, as discussed earlier, the provision of instruction in diagrammatic forms rather than descriptive forms would facilitate understanding and solving problems.

5. Develop instructional materials and tests.

At this stage the actual instructional messages, such as directions, information presentations, practices, feedback, and test items were written on paper in draft form. In the selection of media, it was decided that the prerequisite test and instructional units be presented by computer-based instruction (CBI). The rationale for using CBI in statistics was two fold: (1) evidence from the literature indicates that CBI is useful in statistics instruction. For example, Varnhagen and Zumbo (1990) found that computer-assisted instruction had a significant effect on student attitude toward statistics instruction and had an indirect effect over performance through its influence on affect. They recommended that technical courses such as introductory statistics should ideally be supplemented with CBI in order to provide optimal learning experiences; (2) the use of CBI facilitates the research issues, e.g., software ensures that the experimental treatments were provided as designed. Upon completion of written draft of the material, storyboards were produced with each page corresponding to a separate computer screen display. The computer-based instructional materials were programmed in an authoring system, IconAuthor (AIMtech, 1989) and were delivered by an IBM personal computer.

After the prerequisite test and the four instructional units were developed, they were checked to ensure that the instructions were coherent and the program was free of functional errors before the formative evaluation took place. The following issues were considered when the investigator worked through the program (Alessi & Trollip, 1985; Olson & Wilson, 1985):

A. Is the use of words and symbols involved in hypothesis testing consistent throughout the program?
B. Is the spelling, grammar, punctuation, and spacing free of error and consistent?
C. Are the directions properly and clearly given for the subjects to proceed with the experiment?
D. Is the information covered in the treatment complete and accurate, and placed in the proper sequence? And, is the design method used in the study well reflected in the information provided?
E. Are the questions and feedback handled properly?
    1) Are the practice items placed in the proper sequence? In other words, are the practice items related to the information being presented?
    2) Are the questions/practice items unambiguous?
    3) Is the feedback appropriate and increasingly informative after each successive incorrect response?
    4) Are the subjects' performance, i.e., scores, number of attempts, and time to completion, recorded accurately?

F. Is the screen designed properly?
  1) Is the amount of information proper for each screen?
  2) Are the diagrams drawn in the proper place?
  3) Is the type size and style, highlights, inverse, or animation used in an instructional relevant way, but not overused?
  4) Are the feedback messages displayed on the lower part of the screen in a consistent manner?
  5) Is the screen continued from the last screen noted by the heading and continuation remark?
  6) Is the timing of text output relevant or controlled by the subjects?

Posttest items were prepared in paper-and-pencil format because the mode of the posttest was think-aloud protocol. The posttest consisted of 17 problems representing major concepts or rules involved in introductory hypothesis testing. Each problem was typed on a separate sheet and subjects could use the blank space for computation or drawing diagrams while performing the think-aloud protocol.

Coding system for the protocol analyses was developed based on the posttest items and a theoretical framework of relevant mental models in hypothesis testing. In developing the coding categories, no attempt was made to deal with all the information in the think-aloud protocols. Instead, only selected features of the protocols related to the task were included in the categories. Since the present study was aimed at finding if the subjects built relevant mental models in hypothesis testing, a coding system describing the information processing leading to the solution was developed. The categories in the system also included misconceptions found from the pilot study and formative evaluation. The examples of the coding system and scoring procedures can be found in Hong and O'Neil (in press)

6. Formative evaluation.

After the instructional program development was completed and steps were taken to ensure the program was free of functional errors, a two-stage formative evaluation was conducted: one-on-one testing and small-group testing (Dick & Carey, 1985).

One-on-one testing. The purpose of this testing was to revise the instructional program while it was being developed by using students similar to those for whom the lesson was designed. Because of the small numbers involved in this testing, the information gathered from the testing could only be used to aid further revision, but not for a definitive statement of fact (Alessi & Trollip, 1985). Materials used in this testing were CBI instructional units developed by the investigator.

While each subject worked through the program, the investigator attended the whole session and took notes through unobtrusive observation. The investigator asked the subjects to make comments about the program whenever they encountered difficulty in understanding the directions, presentation, and/or questions. As soon as the subjects finished the treatment session, the investigator discussed with the subjects the comments they made and observations the investigator wrote down.

For the posttest, think-aloud protocol method was employed and recorded for the entire session. After the test, the subjects were asked what they thought of the whole session. Findings from the one-on-one test were used when revisions were made (see Hong, 1990)

Small group testing. After the one-on-one testing, the instructional program including prerequisite test, four treatment units, and posttest items were revised. In this stage of formative evaluation, it was intended to test the revised instructional program and further revise it before the main study. Even though the title--small group testing--was borrowed from Dick and Carey (1985), the testing was conducted at one to one level because think-aloud protocol was employed for the posttest. As with the one-on-one testing, because of the small number of subjects were involved, the information from this testing was used only to guide revision, not for any kind of statistical testing.

In this testing, the subjects were not allowed to ask any questions while studying the material except with the prerequisite test. However, they were encouraged to make notes of comments during the sessions. The investigator sat with the subjects while they studied through the program and took notes of their behavior. A tape recorder was used throughout the posttest session and the subjects were encouraged to think out loud. Findings from the small group testing were used for revision.

7. Revision of instructional program.

Data collected from pilot testing, one-on-one, and small-group testing were used for revising instructional program. In brief, some of test items were revised or deleted; feedback information was elaborated; help screens were added; diagrams were elaborated and explained; and coding categories were revised by analyzing each subject's protocols.

Effects of Mental Model Strategy on Instruction and Learning

To test if the mental model strategies (i.e., separate and diagrammatic presentation) had a positive effect, subjects were drawn from students who were taking introductory statistic courses. The subjects did not have knowledge on the introductory hypothesis testing at the time of the experiment, but had learned the prerequisite information. That is, the experiment was conducted just before the subjects learn the hypothesis testing in their classes. The subjects were grouped into blocks according to their educational levels, i.e., 27 graduates and 29 undergraduates, and a random assignment to each treatment combination was carried out separately for each block of subjects.

An analysis of covariance with a randomized block factorial design was performed on subjects' problem-solving scores. The prerequisite test score was used as a covariate in the data analysis. In addition, an analysis of variance was conducted to examine whether the frequencies of using diagrammatic problem representation differed by the differential treatments of presentation mode and presentation sequence. Data analyses of the study are described in full detail elsewhere (Hong & O'Neil, in press).

The results of the study provide evidence concerning the instructional strategies which help learners build relevant mental models in introductory hypothesis testing. First, providing conceptual instruction prior to procedural instruction significantly facilitated understanding the concepts and the procedures involved in hypothesis testing. Second, instruction using extensive diagrammatic representation facilitated subjects' development of representational ability for understanding the instruction by building diagrammatic mental models.

Research on mental models has found that the use of mental model strategy can enhance learners' acquisition of knowledge, especially where inference process is necessary (Kieras, 1988; Mayer, 1989). The present study suggests that, in the course of instructional design and development, mental model analysis be conducted to determine appropriate instructional strategies.

References

AIMtech (1989). IconAuthor. Nashua, NH: Author.

Alesandrini, R. L. (1984). Pictures and adult learning. Instructional Science, 13, 63-77.

Alessi, S. M., & Trollip, S. R. (1985). Computer-based instruction: Methods and development. Englewood Cliffs, NJ: Prentice-hall.

Anglin, G. L., & Stevens, J. T. (1986). Prose-relevant pictures and recall from science text. Perceptual and Motor Skills, 63, 1143-1148.

Curtis, R. V. (1988). When is a science analogy like a social studies analogy? A comparison of text analogies across two disciplines. Instructional Science, 13, 169-177.

de Kleer, J., & Brown, J. S. (1983). Assumptions and ambiguities in mechanistic mental models. In D. Gentner & A. L. Stevens (Eds.), Mental models (pp. 155-190). Hillsdale, NJ: Lawrence Erlbaum.

Dick, W., & Carey, L. (1985). The systematic design of instruction (2nd ed.). Glenview, IL: Scott, Foresman.

Dick, W., & Reiser, R. A. (1989). Planning effective instruction. Englewood Cliffs, NJ: Prentice Hall.

Dyck, J. L., & Mayer, R. E. (1989). Teaching for transfer of computer program comprehensive skill. Journal of Educational Psychology, 81(1), 16-24.

Gagné, R. M., Briggs, L. J., & Wager, W. W. (1988). Principles of instructional design (3rd ed.). New York: Holt, Rinehart and Winston.

Gagné, R. M., & Merrill, M. D. (1990). Integrative goals for instructional design. Educational Technology Research and Development, 38(1), 23-30.

Gentner, D., & Stevens, A. L. (Eds.) (1983). Mental models. Hillsdale, NJ: Lawrence Erlbaum.

Hong, E. (1990). An instructional strategy to help learners build relevant mental models in inferential statistics: Presentation sequence and presentation mode. Unpublished doctoral dissertation, University of Southern California, Los Angeles.

Hong, E., & O'Neil, H. F., Jr. (in press). Instructional strategies to help learners build relevant mental models in inferential statistics. Journal of Educational Psychology.

Kieras, D. E. (1984). A simulation model for procedure inference from a mental model for a simple device (Contract No. N00014-81-C-0699). Washington, DC: Office of Naval Research.

Kieras, D. E. (1987). The role of cognitive simulation models in the development of advanced training and testing systems (Tech. Rep. No. 23). Ann Arbor, MI: University of Michigan.

Kieras, D. E. (1988). What mental model should be taught: Choosing instructional content for complex engineered system. In J. Psotka, L. D. Massey & S. A. Mutter (Eds.), Intelligent tutoring systems: Lessons learned (pp. 85-111). Hillsdale, NJ: Lawrence Erlbaum Associates.

Kieras, D. E., & Bovair, S. (1984). The role of a mental model in learning to operate a device. Cognitive Science, 8, 255-273.

Mayer, R. E. (1989). Models for understanding. Review of Educational Research, 59(1), 43-64.

Mayer, R. E., Dyck, J. L., & Cook, L. K. (1984). Techniques that help readers build mental models from scientific text: Definitions pretraining and Signaling. Journal of Educational Psychology, 76(6), 1089-1105.

Minsky, M. (1975). A framework for representing knowledge. In P. H. Winston (Ed.)., The psychology of computer vision (pp. 211-277). New York: McGraw-Hill.

Norman, D. A. (1986). Cognitive engineering. In D. A. Norman & S. Draper (Eds.), User centered system design: New perspectives on human-computer interaction (pp. 31-61). Hillsdale, NJ: Lawrence Erlbaum.

Olson, S., & Wilson, D. (1985, February). Designing Computer Screen Displays. Performance and Instruction Journal, 16-17.

Reid, D. J., & Beveridge, M. (1986). Effects of text illustrations on children's learning of a school science topic. British Journal of Educational Psychology, 56, 294-303.

Reigeluth, C. M. (Ed.). (1983). Instructional-design theories and models: An overview of their current status. Hillsdale, NJ: Lawrence Erlbaum.

Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. Spiro, B. Bruce, & W. Brewer (Eds.), Theoretical issues in reading comprehension (pp. 33-58). Hillsdale, NJ: Lawrence Erlbaum.

Rusted, J., & Hodgson, S. (1985). Evaluating the picture facilitation effect in children's recall of written texts. British Journal of Educational Psychology, 55, 288-294.

Schank, R. C., & Abelson, R. P. (1977). Scripts, plans, goals and understanding: An inquiry into human knowledge structures. New York: Academic Press.

Streitz, N. A. (1988). Mental models and metaphors: Implications for the design of adaptive user-system interfaces. In H. Mandl & A. Lesgold (Eds.), Learning issues for intelligent tutoring systems (pp. 164-186). New York: Springer-Verlag.

Varnhagen, C. K., & Zumbo, B. D. (1990). CAI as an adjunct to teaching introductory statistics: Affect mediates learning. Journal of Educational Computing Research, 6(1), 29-40.

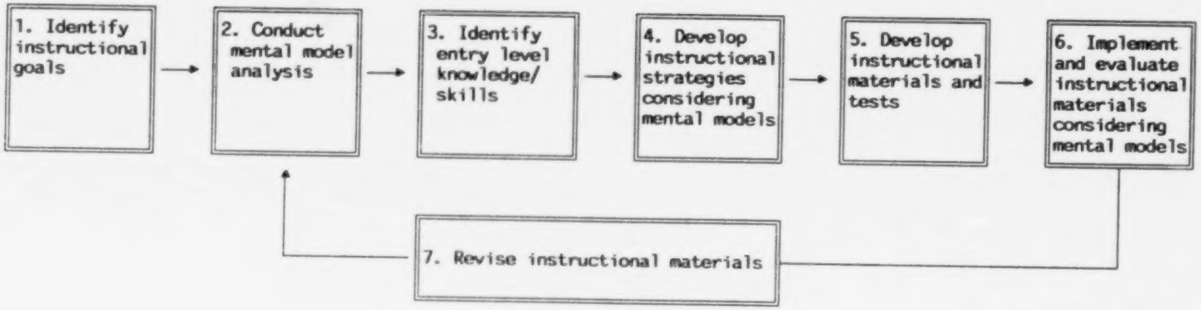
White, B. Y., & Frederiksen, J. R. (1986). Progressions of qualitative models as a foundation for intelligent learning environments (Report No. 6277). Cambridge, MA: BBN Laboratories.

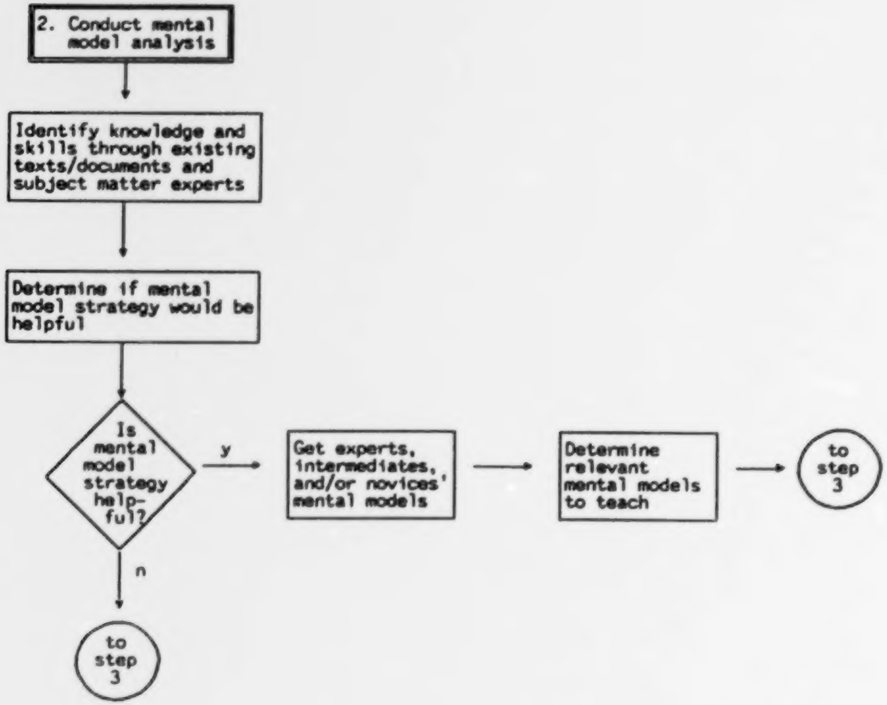
Wilson, J. R., & Rutherford, A. (1989). Mental models: Theory and application in human factors. Human Factors, 31(6), 617-634.

Figure Caption

Figure 1. A model for instructional systems design with mental models analysis.

Figure 2. Procedures for conducting mental model analysis.


1. Identify instructional goals
2. Conduct mental model analysis
3. Identify entry level knowledge/ skills
4. Develop instructional strategies considering mental models
5. Develop instructional materials and tests
6. Implement and evaluate instructional materials considering mental models
7. Revise instructional materials


2. Conduct mental model analysis
Identify knowledge and skills through existing texts/documents and subject matter experts
Determine if mental model strategy would be helpful
Is mental model strategy help- ful?
y
Get experts, intermediates, and/or novices' mental models
Determine relevant mental models to teach
to step 3
n
to step 3

Title:

Generative Learning in Small Groups

Authors:

Simon Hooper
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Generative Learning in Small Groups

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AECT , 1992

Abstract

This research attempted to replicate and extend results from a previous study examining the effects on achievement of generating summaries or analogies while reading a lengthy text. Before the study, 111 students were classified as high or low ability and were randomly assigned to paired or individual conditions and to one of three experimental treatments: a summaries group; an analogies group; or, a control group. Posttest achievement was higher for students who generated summaries (mean =21.41) than for students who generated analogies (mean = 17.75). Furthermore, a significant interaction indicated that high ability students learned more effectively studying alone (mean = 25.47) than in pairs (mean = 18.55). Reasons for the ineffectiveness of the paired treatment are discussed.

Generative Learning in Small Groups

Students often read instructional texts superficially resulting in poor recall and transfer. Generative learning attempts to improve learning from text by providing students with methods that stimulate deeper processing (Wittrock, 1990). Generative learning emphasizes forming relations among information to be learned and between the information and the learner's knowledge and experiences.

In a recent study, Wittrock and Alesandrini (1990) examined the effects of three processing strategies on students' ability to comprehend and retain information from text. After reading each paragraph of a text, students employed one of two generative learning techniques (summarizing each paragraph's main idea or writing an analogy associating the text with the reader's personal knowledge base) or simply re-read each paragraph. Students who generated analogies or summaries demonstrated higher posttest achievement than did students who re-read the text, but no differences were found between the generative treatments.

Although achievement differences for the two generative activities were not different, data indicate that students were more facile generating summaries than analogies. During the treatments, students generated appropriate summaries with 99% success and analogies with 75% success. These data suggest that generating analogies is more difficult than generating summaries. Moreover, difficulties generating analogies may have suppressed students' posttest achievement. Learning for the analogies treatment may have improved if students had generated more effective analogies.

Content organizing and integrating activities may be more effective when working with a partner rather than alone. Although studies have focussed on learners working individually, generative learning may be more effective in groups. The cognitive effects of working in small groups are well established. A meta-analysis comparing group with individual learning produced an effect size of .63 favoring grouping (Johnson & Johnson, 1989). Furthermore, in a study comparing the effects of summarizing text individually or in groups, students who generated summaries in dyads learned more than students who generated summaries alone (O'Donnell et al.,1987). Students often learn more effectively in an environment that provides opportunities to share information and engage in constructive conflict.

Generating analogies in small groups may also stimulate learning. Difficult tasks are often solved more effectively in small groups than when working alone (King, 1989). However, two important questions exist concerning the formation of a group analogy. First, can collaborating students create more effective analogies than students working alone? Second, can an analogy formed by consensus improve learning? Cooperation may deepen processing and improve recall for both partners. Alternatively, a group analogy may furnish information that benefits only one partner or is not particularly useful to either group member (Dansereau, 1987). In such cases, group learning may be no more, and potentially less, effective than studying alone.

The purposes of the present study were to replicate and extend Wittrock and Alesandrini's (1990) study. We investigated the effects of using generative learning techniques to learn from text while studying alone and in small groups. Furthermore, we examined whether students working in groups generated more effective summaries and analogies during instruction than did students working alone.

Method

Subjects

A sample of 111 undergraduate students from a mid-western university completed the study. Students received extra course credit in computer-science for participating.

Materials

Pretests. The purpose of the pretest was to measure verbal-analytic ability. Verbal-analytic ability was measured with the Similarities Subtest of the Weshsler Adult Intelligence Scale[1] (WAIS) (Wechsler, 1958). Students were classified as high or low ability according to pretest performance. High ability students scored above the mean and low ability students scored below the mean on the pretest. The mean score for the high ability students on the pretest was the 73rd percentile and mean for the low ability students was the 53rd percentile.

Text. Subjects read a 6,200 word chapter about marine life[2]. The text, which was the same as that used in several previous research studies, was originally selected for its high imagery content and was intended to stimulate imagery processing. After each paragraph students were referred to an answer booklet. The answer booklet contained the instructions for each treatment.

Posttest. A 68-item posttest measured literal comprehension. A typical posttest question is: "A hydrophone network set up by the Navy to protect (Chesapeake) Bay during World War II was temporarily made useless by noise made by fish." Since the original 72 item posttest was unavailable, the posttest was constructed from items provided by Dr. Ernst Rothkopf[3]. The KR-21 reliability for the posttest was 0.74.

Summaries and analogies. The summaries and analogies generated during the experiment were analyzed to determine the degree to which students followed instructions during the experiment. These scores were analyzed further to determine the extent to which the experimental treatments influenced posttest achievement. Each analogy or summary generated according to directions provided during the experiment scored two points. An analogy or summary which only partially complied with directions scored one point. Other generations did not receive a point. An example of a student generated summary is: "Sperm whales go deep down in the ocean to feed on animal life. Squids inhabit this region also." An example of a student generated analogy is: "Sir John Ross has shown proof that there is some form of life 'worms' at a depth of 1000 fathoms. Not too surprising--worms like a dark wet environment."

Design

The study employed a 2X2X2 factorial design with two appended control groups. The factors included Grouping (Individuals, Pairs), Treatment (Summary, Analogy), and Ability (High, Low). In one control group students studied alone and read each paragraph twice before continuing to read the passage. In the other control group students studied in pairs and recorded comments to learn as much as possible from each paragraph, but were not directed how to interact or as to the nature of information to record. Dependent measures included posttest achievement and time on task. Also, students in the analogies and summaries treatments received scores for writing produced during the experiment

Procedures

The pre-test was completed approximately one week before the study. Prior to the experiment, students were randomly assigned to work individually or in pairs, and to one of two treatment groups or two control groups resulting in six analysis groups (Individual summary, Individual analogy, Individual re-read, Paired summary, Paired analogy, Un-scripted pairs). Students working alone received identical instructions to those provided in a previous study (Wittrock & Alesandrini, 1990). All students were instructed to record the start and finish time of the experiment. Students assigned to the Summary treatment were instructed to read and review a paragraph of text and then to summarize each paragraph in a space provided in an answer booklet. A summary was described as consisting of one or two sentences that state the main idea or topic of a paragraph. Students were asked not to copy sentences directly from the passage, not to use any terminology from the paragraph, and to write the sentences in their own words.

A similar statement was provided for students in the analogy treatment. Students were asked to review each paragraph and to write an analogy associating the content from the text with things that students already knew about. An analogy was described as consisting of one or two sentences which clearly related the new ideas to familiar things or experiences.

Students in the re-read treatment were instructed to record the time before, and again upon completing, reading each paragraph. After recording the finish time, students were instructed to re-read each paragraph. Students were also informed that the experiment was not examining speed reading and that recording the time helped to fulfill an important experimental condition.

Students assigned to the paired Summary and Analogy treatments received identical instructions to the corresponding individual treatments, together with instructions to work together to form analogies/ summaries for each paragraph, to share ideas and experiences, and that each partner should write an analogy/summary individually in their answer booklets. Students working in the paired control group were instructed to work with their partner, to remember as much of the passage as possible, and to enter relevant comments into an answer booklet after reading each paragraph.

Results

Posttest Achievement

Posttest means and standard deviations are contained in Table 1. A significant difference was found for Grouping, $F(1,67)= 7.73$, $p<.01$. Students who completed the instruction individually scored higher than students who completed the instruction in pairs (means 21.73 and 17.63). A significant difference was also found for Treatment, $F(1,67)= 4.75$, $p<.03$. Students who completed the Summary treatment scored higher than students who completed the Analogy treatment (means 21.41 and 17.75). A significant interaction was found between Ability and Grouping, $F(1,67)= 5.10$, $p<.03$. The interaction is shown in Figure 1. Follow-up comparisons indicated that the achievement scores for high ability studying alone were higher than those of high ability students studying in pairs and students working alone. No statistically reliable differences were found between the treatment and control groups.

Insert Table 1 and Figure 1 About Here

Time On Task

No differences were found for time on task. However, posttest scores were divided by time on task to produce a measure of learning efficiency. This metric produced a significant difference for Grouping $F(1,67)= 12.22$, $p<.001$. The learning rate for students who completed the instruction individually was higher than for students who worked in pairs (means 0.267 and 0.200). A significant difference was also found for Treatment $F(1,67)= 4.05$, $p<.05$. Students who completed the Summary treatment were more efficient than students who completed the Analogy treatment (means 0.253 and 0.210).

Summaries and Analogies

Posttest means and standard deviations are contained in Table 2. Significant correlations were found between posttest achievement and summaries, $r(39)= .318$, $p<.05$, and posttest achievement and analogies, $r(36)= .373$, $p<.05$. Further analyses investigated the quantity generated individually and in pairs. Separate independent t-tests were used to examine the quantity of analogies and summaries generated in paired and individual treatments. Analysis of the summaries produced a significant difference for Grouping, $t(37)= 2.402$ $p<0.05$. Students working alone generated significantly more summaries than students working in pairs (means 87.11 and 79.50). However, the analysis of analogies was not significant $t(34)= 0.72$ $p>0.05$. The means of students working alone (mean= 40.11) and in pairs (mean= 42.78) were not reliably different.

Insert Table 2 About Here

Discussion

Students working alone scored significantly higher on the posttest than students working in pairs. Moreover, the significant interaction between Ability and Grouping indicates that pairing impaired high ability students performance when learning from text, but did not affect the low ability students. Achievement was significantly higher for high ability students working individually (mean = 24.81) than in groups (mean = 19.04). However, achievement differences between low ability students working alone (mean = 17.88) and in small groups (mean = 17.70) were not significant. In other words, grouping hampered only the high ability students. Furthermore, pairing reduced instructional efficiency. Individuals completed instruction significantly more efficiently than collaborators.

These results deviate from research supporting small group interventions. Most studies report significant advantages gained from collaboration. Furthermore, although some studies suggest that not all students benefit from collaboration (Webb, 1982a; Beane & Lemke, 1971), several studies support the efficacy of grouping for all ability groups. For example, two studies reported that high, average, and low ability second and third grade students demonstrated higher performance after collaborating than after working alone (Yager, Johnson, & Johnson, 1985; Yager, Johnson, Johnson, & Snider, 1986). Similarly, high, average, and low ability students demonstrated higher achievement and lower math anxiety after completing a computer-based integrated learning system in pairs rather alone (Mevarech, Silber, & Fine, 1991). Hooper (in press), also reported that high and average ability fifth and sixth grade students, working in heterogeneous or homogeneous ability groups, outperformed their counterparts working alone while completing a computer-based tutorial.

Two explanations for the present findings are suggested. First, students working in groups may have experienced the free rider effect (Kerr & Bruun, 1983). The free rider effect is a phenomenon that occurs in groups when individual effort is presumed to be unnecessary due to the perceived competence of other members. The resulting reduced effort is manifested in reduced group performance. In the present study, paired students may have invested less effort in the learning task than students working alone, relying instead on their partners to furnish the required information. This conjecture is supported, in part, by the count of the summaries generated during the experiment. Means for summaries were significantly higher for students working alone than in pairs. Further inspection reveals significant differences between high ability students' generations, but only small differences between the low ability students' generations. High ability students may have believed their partners were competent at forming effective summaries and consequently invested less personal effort in the task.

Second, students may have interacted ineffectively. Researchers generally agree that the efficacy of small group learning is linked to the nature of intra-group interaction (Webb, 1982b; Hooper, in press). Effective interaction stimulates cognitive effort which in turn mediates deeper processing (Salomon, 1984; Wittrock, 1990). However, appropriate small group interaction often does not occur naturally, and simply encouraging college students to work together may be ineffective (Carrier & Sales, 1987). Unlike school children who socialize frequently, many college students have little social contact with their class peers and may not interact effectively when asked to do so.

Another finding from the present study is that working with a partner did not help students to generate effective analogies and did not enhance posttest performance. Students in the Summary treatment demonstrated higher posttest performance and greater instructional efficiency than students in the Analogy treatment. Furthermore, means for the count of the summaries generated during instruction were more than double the means for the analogies count. Although direct comparison must be made with caution, these differences indicate that students in the Analogy treatment experienced difficulties completing their task. Means for achievement, generations, and time-on-task for each of the text processing strategies included in this and the Wittrock and Alesandrini (1990) study are included in Table 3.

Insert Table 3 About Here

The present study failed to replicate Wittrock and Alesandrini's (1990) finding that students using generative learning strategies demonstrated higher posttest performance than students who re-read a passage. Little evidence exists to explain this finding, although some differences existed in the administration of the original and the replication studies. Although both studies employed identical stimulus materials the posttest used in the present study differed from the original posttest. Also, students in the original study completed the experimental treatments in sessions of 4-6 people. In the present study, the treatments were administered in sessions of approximately 30 people.

Effective interaction may require interdependence among group members and guidance in using interaction techniques. Salomon (1989) suggested that the cognitive benefits of group learning are limited to the extent that students are interdependent and that group members must commit to common goals and agree to coordinate and invest effort in order to experience the cognitive benefits of group learning. Salomon also proposed that interdependence is likely to be low during short research studies involving subjects with little previous interpersonal knowledge or interaction and that under such conditions small groups may be ineffective learning environments.

Future research should focus on teaching students to interact effectively in groups and to generate analogies. Without prior practice, many students are unlikely to generate effective analogies. Furthermore, research examining methods to stimulate intra-group interaction suggests that students must be guided to interact effectively. Without guidance students working in small groups often model teaching techniques that are familiar, but unrelated to group success (McKellar, 1986).

Notes

1. Weshsler Adult Intelligence Scale. Copyright © 1955 by The Psychological Corporation. Reproduced by permission. All rights reserved.
2. From The Sea Around Us, Revised Edition, By Rachel L. Carlson. Copyright © 1950, 1951, 1961 by Rachel L. Carlson; renewed 1979 by Roger Christie. Reprinted by permission of Oxford University Press, Inc.
3. The authors wish to thank Dr. Ernst Rothkopf of Teachers College, Columbia University, for supplying the test used in this study.

References

Beane, W. E., & Lemke, E. A. (1971). Group variables influencing the transfer of conceptual behavior. Journal of Educational Psychology, 62, 215-218.

Carrier, C. A., & Sales, G. C. (1987). Pair versus individual work on the acquisition of concepts in a computer-based instructional lesson. Journal of Computer-Based Instruction, 14, 11-17.

Dansereau, D. F.(1987). Transfer from cooperative to individual studying. Journal of Reading, April, 614-618.

Hooper, S. (In press). The effects of peer interaction on learning during computer-based mathematics instruction. Journal of Educational Research.

Hythecker, V. I., Dansereau, D. F., & Rocklin, T. R. (1988). An analysis of processes influencing the structured dyadic learning environment. Educational Psychologist, 23, 23-38.

Johnson, D. W., & Johnson, R. T. (1989). Cooperation and competition: Theory and research. Edina, MN: Interaction Book Company.

Kerr, N. L., & Bruun, S. E. (1983). The dispensability of member effort and group motivation losses: Free-rider effects. Journal of Personality and Social Psychology, 44, 78-94.

King, A. (1989). Verbal interaction and problem-solving within computer-assisted cooperative learning groups. Journal of Educational Computing Research, 5, 1-15.

Larson, C. O., Dansereau, D. F., O'Donnell, A. M., Hythecker, V. I., Lambiotte, J. G., & Rocklin, T. R. (1985). Effects of metacognitive and elaborative activity on cooperative learning and transfer. Contemporary Educational Psychology, 10, 342-348.

McKellar, N. A. (1986). Behaviors used in peer tutoring. Journal of Experimental Education, 54, 163-168.

Mevarech, Z. R., Silber, O., & Fine, D. (1991). Learning with computers in small groups: Cognitive and affective outcomes. Journal of Educational Computing Research, 7(2), 233-243.

O'Donnell, A. M., Dansereau, D. F., Hall, R. H., & Rocklin, T. R. (1987). Cognitive, Social/affective, and metacognitive outcomes of scripted cooperative learning. Journal of Educational Psychology, 79, 431-437.

Salomon, G. (1984). Television is "easy" and print is "tough": The differential investment of mental effort in learning as a function of perceptions and attributions. Journal of Educational Psychology, 76, 647-658.

Salomon, G. (1988, April). When teams don't function the way they ought to. Paper presented at the meeting of the American Educational Research Association, New Orleans, LA.

Spurlin, J. E., Dansereau, D. F., Larson, C. O., & Brooks, L. W. (1984). Cooperative learning strategies and descriptive text processing: Effects of role and activity on the listener. Cognition and Instruction, 1, 451-463.

Webb, N. M. (1982a). Peer interaction and learning in small cooperative groups. Journal of Educational Psychology, 74, 642-655.

Webb, N. M. (1982b). Student interaction and learning in small groups. Review of Educational Research, 52, 421-445.

Wechsler, D. (1958). The measurement and appraisal of adult intelligence. Baltimore: Williams and Wilkin Co.

Wittrock , M. C. & Alesandrini, K. (1990). Generation of summaries and analogies and analytic and holistic abilities. American Educational Research Journal, 27(3), 489-502.

Wittrock, M. C. (1990). Generative processes of comprehension. Educational Psychologist, 24(4), 345-376.

Yager, S., Johnson, D. W., & Johnson, R. T. (1985). Oral discussion, group-to-individual transfer, and achievement in cooperative learning groups. Journal of Educational Psychology, 77, 60-66.

Yager, S., Johnson, D. W., Johnson, R. T., & Snider, B. (1986). The impact of group processing on achievement in cooperative learning groups. Journal of Social Psychology,126, 389-397.

Figure 1. Interaction between Ability and Grouping

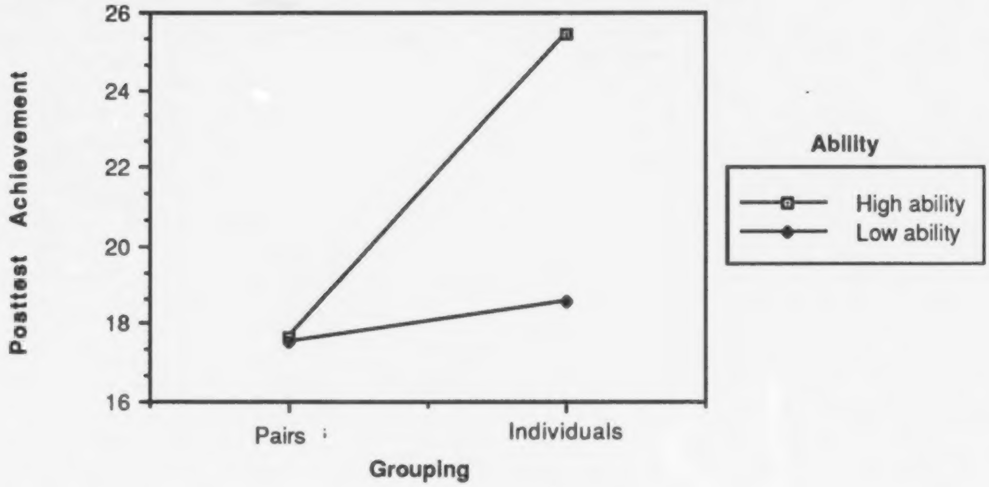

Table 1: Achievement and Time-on-task Means and Standard Deviations

Group Ability		Posttest	Time-on-task
Individuals			
High			
Re-read	M	23.20	74.80
(n=10)	SD	9.69	11.92
Summary	M	27.00	82.40
(n=10)	SD	6.77	12.46
Analogy	M	23.29	86.43
(n = 7)	SD	6.02	14.54
Total	M	25.47	84.06
(n=17)	SD	6.55	13.07
Low			
Re-read	M	19.00	91.25
(n=10)	SD	8.70	17.02
Summary	M	19.56	88.78
(n=9)	SD	5.39	14.64
Analogy	M	17.73	80.64
(n = 11)	SD	7.63	14.68
Total	M	18.55	84.30
(n=20)	SD	6.61	14.87
Pairs			
High			
Comments	M	21.38	88.88
(n=10)	SD	8.11	13.95
Summary	M	19.15	83.62
(n=13)	SD	6.49	9.24
Analogy	M	15.56	90.22
(n = 9)	SD	6.19	18.75
Total	M	17.68	86.32
(n=22)	SD	6.48	13.92
Low			
Comments	M	18.50	85.10
(n=10)	SD	9.11	8.39
Summary	M	20.00	90.14
(n=7)	SD	6.88	13.23
Analogy	M	15.67	95.22
(n = 9)	SD	6.60	21.78
Total	M	17.56	93.00
(n=16)	SD	6.86	18.16

Table 1 (cont): Main Effects Summary

		Posttest	Time
Group			
Individuals (n=37)	M	21.73	84.19
	SD	7.37	13.87
Pairs (n=38)	M	17.63	89.13
	SD	6.55	15.97
Ability			
High (n=39)	M	21.08	85.33
	SD	7.52	13.43
Low (n=36)	M	18.11	88.17
	SD	6.65	16.75
Treatment			
Summary (n=39)	M	21.41	85.67
	SD	6.99	12.11
Analogy (n=36)	M	17.75	87.81
	SD	7.07	17.85

Table 2
Summary and Analogy Ratings Means and Standard Deviations

Grouping			Generation	
	Ability		Summary	Analogy
Pair				
	High	M	77.6	43.6
		SD	12.8	10.24
		n	(14)	(9)
	Low	M	83.8	42.0
		SD	9.4	10.3
		n	(6)	(9)
	Total	M	79.5	42.8
		SD	12.1	9.9
		n	(20)	(18)
Individual				
	High	M	87.3	46.3
		SD	7.6	7.2
		n	(10)	(7)
	Low	M	86.9	36.2
		SD	6.4	13.4
		n	(9)	(11)
	Total	M	87.1	40.1
		SD	6.9	12.2
		n	(19)	(18)

Table 3
Means and Standard Deviations for Original and Replication Studies

	Treatments					
	Individuals			Pairs		
Learning & abilities	Read text	Generate summaries	Generate analogies	Generate comments	Generate summaries	Generate analogies
Learning (72 items)	(n=19)	(n=19)	(n=19)			
(O)Mean	22.4	29.8	27.2			
(O)SD	(9.2)	(7.7)	(6.3)			
Learning (68 items)	(n=18)	(n=19)	(n=18)	(n=18)	(n=20)	(n=18)
(R)Mean	21.33	23.47	19.89	19.78	19.45	15.61
(R)SD	(9.25)	(7.01)	(7.40)	(8.55)	(6.46)	(6.20)
Generations (100 maximum)						
(O)Mean	.	98.7	75.4			
(O)SD	.	(2.4)	(23.3)			
Generations (100 maximum)						
(R)Mean		87.12	40.11	.	79.50	42.78
(R)SD	.	6.88	12.25	.	12.06	9.99
Time to Learn (minutes)						
(O)Mean	76.1	86.3	85.2			
(O)SD	(21.6)	(18.6)	(15.3)			
Time to Learn (minutes)						
(R)Mean	82.11	85.41	82.89	86.78	85.90	92.72
(R)SD	(16.28)	(13.55)	(14.48)	(11.01)	(10.93)	(19.88)

Note: O represents scores from the original study. R represents scores from the replication study.

Title:

Problem Identification Techniques: So What's the Problem

Authors:

Alan Januszewski
Robert Pearson

Introduction

Problem identification is arguably the most crucial aspect of the needs assessment process in instructional development. Yet little attention has been given by instructional developers to clearly delineating what is meant by the term 'problem'. This is troublesome given that many definitions of the word problem exist. For example, the *Oxford English Dictionary* describes no fewer than six different kinds of problems. This suggests that the way one identifies a problem shapes the way one views the problem solving process, and in turn influences the kinds of problems found during a needs assessment. We contend that getting clearer about how one identifies problems is crucial for a field that has been described as being primarily a problem solving process (AECT, 1977, Romiszowski,1981).

A potentially useful approach to problem clarification may be the use of evaluation models. There are many similarities between program evaluation and needs assessment in instructional development. Many of the functions that occur in program evaluation have, historically at least, occured in needs assessment. Clients are consulted, data is gathered, reports are written, and recommendations made. But there is one important and potentially useful difference - evaluators are often explicit about the value perspective they bring to a project through the evaluation model(s) they consciously adopt. A closer examination of these models may yield useful frameworks for instructional developers as they tackle a needs assessment.

The purpose of this paper, then, is to develop different approaches to clarifying problems in the instructional development process. This will be done by: 1) defining what a problem is and what types of problems typically face instructional developers; 2) presenting a rationale for suggesting the use of evaluation models for finding development problems; 3) suggesting how the use of a particular evaluation approaches may result in the finding of different problems.

What Is A Problem?

The concept of problem is very complex. Although we often take its meaning for granted. Academicians tend to describe the term in ways that may be foreign to us. One example of this is Clark's (1979) definition:

> a situation resulting from the interaction or juxtaposition of factors which yields a perplexing or enigmatic state, an undesirable consequence, or conflict. The juxtaposition can take the form of provocative exceptions, contradictory evidence, a knowledge void, or a theoretical action-knowledge conflict (as cited in Jorgenson,1981 p.9).

The difficulty with a definition like Clark's is that it is not easily understood by practising instructional developers or their clients and is open to various interpretations. Clearly understanding some of these interpretations would be helpful for individuals engaged in the instructional development process. A dictionary definition is a useful starting point in identifying the different interpretations of the term problem.

The *Oxford English Dictionary* (1989), for example, identifies six kinds of problems:

> problem - a thing thrown or put forward; hence, a question propounded for a solution, a set task, a problem.
>
> 1. A difficult or puzzling question proposed for a solution; a riddle; an enigmatic statement.
>
> 2. a. A question proposed for academic discussion or scholastic disputation.
>
>   b. *Logic*. The question (expressed, or, more usually, only implied) involved in a syllogism, and of which the conclusion is the only solution or answer.
>
> 3. a. A doubtful or difficult question; a matter of inquiry, discussion, or thought; a question that exercises the mind.
>
>   b. Problematic quality; difficulty of solution..
>
>   c. As the second element in various Combs. and collocations describing: (a) a supposedly insoluble quandary affecting a specified group of people or a nation; (b) a real or imagined chronic personal difficulty, *as credibility, drink, health, weight problem*.
>
>   d. In various colloq. phrases, as *no problem*, simple easy, 'the question does not arise'; *that's your* (*his*, etc.) *problem*, used to disclaim responsibility or connection.
>
> 4. *Geom*. A proposition in which something is required to be done: opposed to *theorem*..
>
> 5. *Physics* and *Math*.. A question or inquiry which starting from some given conditions investigates some fact, result, or law.
>
> 6. *Chess* . An arrangement of pieces upon the chessboard for play in accordance with the rules of the game or other prescribed conditions, in which the player is challenged to discover the method of accomplishing a specified result.

The number and substance of these definitions suggests that there are different kinds of problems and different uses of the word 'problem'. If one accepts that there are different kinds of problems, and different uses of the word problem, significant questions arise,'what problems are most likely to find their way into the practice of the professional who solves problems?' Are professionals who solve problems aware that different kinds of problems exist? Are they trained to solve different kinds of problems? Are certain kinds of professions only concerned with particular kinds of problems?

It would seem that all professionals must address, at one time or another, problems of 'academic discussion and scholastic disputation' and 'difficult questions that exercise the mind'. Some professionals, such as medical doctors or architects, look to attain some specified result, although, it would seem that they have a number of different avenues or methods available to do this (definition number 6). Others, such as chemists or physicist, seek to investigate a mathematical or scientific law or result (definition number 5).

Why should instructional developers be concerned with the concept of problem? Simply put, because problem solving is an integral part of what instructional developers do (Romiszowski, 1981; Dick & Carey, 1990). This emphasis can be clearly seen in the most recent definition put forth by the Association for Educational Communications and Technology, the largest professional organization for instructional developers in the United States:

> Educational technology is a complex, integrated process, involving people, procedures, ideas, devices and organization, for analyzing *problems* and devising, implementing, evaluating and managing solutions to those *problems*, involved in all aspects of human learning [emphasis added] (AECT,1977, p. 1).

How Instructional Developers See Problems

But what kind of problems do professional instructional developers typically deal with? It is our contention that the field of instructional development treats problems as essentially solvable. Problems are, in fact, generated to be solved in instructional development and needs assessment is the stage in the instructional development process where a problem is identified. Kaufman and English outline important considerations in a needs assessment:

> the formal harvesting, collection, and listing of needs in priority order, and selecting the needs of highest priority for action. This process includes the partners in planning, which in education are learners, the implementers, and the society. It requires that there be a consensus of the partners in the prioritization of needs, and it strongly urges that the process include any additional external referent of survival and contribution when determining need priorities. (Kaufman and English,1979,pp. 343-344).

But what exactly is a need? The most common definition of 'need' in the literature of educational technology and instructional development is that it is a discrepancy or gap between the current situation and a desired one-"a discrepancy between what is and what is required" (Kaufman,1968, p. 415). Problems in instructional development are needs. Needs are gaps in performance outcomes, and these outcomes are to be stated in measurable terms (Kaufman & English,1979). Kaufman and English relate problems to needs as:

> Problems are needs selected for closure - if there is no gap, there is no problem. The problem identification, properly done, starts with an appropriate assessment of needs. A Needs Assessment is the determination of documentable and important gaps between current outcomes and desired outcomes, and the placing of those gaps in priority order for closure (Kaufman & English, 1979, p.24)

Following this line of thinking, problems in instructional development are not questions for scholarly inquiry or academic disputation. The identification of a problem in instructional development is a call for action (closure); it requires that something be done. Further, it is a call for a technical sort of action -- action following a set of pre specified guidelines. Viewed in this way, instructional development problems are perhaps most akin to the Oxford English Dictionary problem type four "a proposition in which something is required to be done" and type six "an arrangement of pieces upon the chessboard for play in accordance with the rules of the game or other prescribed conditions, in which the player is challenged to discover the method of accomplishing a specified result".

The latter definition of problem, one couched in the analogy of a chess game, is useful in helping understand how instructional developers view the problem solving process. The analogy suggests four things about the way problems are solved by instructional developers. 1) There are a set of rules under which the activity must operate. 2) There is ultimately one desired outcome: the problem that has been identified must be solved. 3) While there are rules, there are nevertheless, many ways to solve an instructional development problem. 4) It is clear when the instructional development problem has been solved.

The Problems With Traditional ID Problems

There are two important ways in which the chess analogy to instructional development breaks down. One is that, in chess the outcome is measurable. It is easily ascertained, according to the rules, whether one has won, lost, or drawn. In instructional development, outcomes are construed so that they can be measured. This requires interpreting the situation so that the desired state can be measured.

The other is that the problem of chess exists before two players begin the game. It is a given. It is not open to the interpretation of the players. The problem exists *a priori*. In contrast, however, problems in instructional development are not a given. They are consciously generated *during* the instructional development process. An instructional development problem is socially construed. It is generated by the individuals engaged in the instructional development process. An instructional development problem, therefore, can not exist *a priori*.

Concerns have been raised about the activities and intentions of needs assessment. First, can needs assessment be responsive to the intent of the planning partners or clients if it is converting the data and information that was gathered to determine educational goals into precise and measurable objectives? It seems that a certain degree of 'distortion' is inevitable when operationalizing goals into measurable objectives (Jorgenson,1981). Can the intent of the planning partners or clients be truly represented and maintained after this process has taken place?

Even Robert Mager, the person who may be most responsible for making the use of behavioral objective popular, suggests that goals cannot easily be translated into measurable objectives:

> Though it is not always possible to describe an intent clearly, and though it is not always possible to determine whether an important outcome has been achieved, instruction can only be considered elegant to the extent that it effectively and efficiently facilitates achievement of instructional intent.(p.20, as cited in Jorgenson,1981)

If the original intent of the planning partners or clients is distorted, how can instructional development meet their real needs? When faced with this question instructional developers often appeal to a consensus of the planning partners. Gaining consensus among the individuals engaged in the instructional development process may be difficult. Can the instructional developer gain a consensuses about output of the information interpretation process? Even if such a consensus were possible to attain (gaining a similar interpretation), can the instructional developer expect to gain a consensus on the prioritization of these interpretations (a question of attaining agreement on values)? Guba and Lincoln argue that:

> ...recent writings in responsive, naturalistic modes of inquiry raise the issue that multiple realities and pluralistic value perspectives render consensus an unreal expectation. If it is achieved, it may be an inauthentic construction superimposed upon the complex realities of the situation. Certainly generalizations are possible, and essential to decision-making and action, but it is important to acknowledge that generalizations about human needs, wants and goals have inextricably subjective, time-bound dimensions to them. "Needs have no objective reality." (Jorgenson,1981 p. 206 citing Guba and Lincoln, 1981, p.1)

This idea applies to both the planning partners and the instructional developer. "Needs are not objectively 'real' and open to discovery by scientific,...value-free methodologies." (Guba and Lincoln,1981, p.1). Needs are grounded in the value systems of the planning partners or clients and the instructional developer. If a need is the 'gap' between where we are and where we want to be, then a need is little more than a way of saying we want something. What we want is, presumably, something we value.

Guba and Lincoln insist that:

> It is time for reassessment of needs assessment, and for the acceptance of a methodology which deals with the values issue squarely, takes values overtly into account, and understands needs for what they are: value expressions. (Guba and Lincoln, 1981, p.20)

We agree with Guba and Lincoln and recommend that the role of values in the problem clarification process be acknowledged and studied. If the role of values is acknowledged then the developer and the planning partners or clients will be more likely to attend to their values as the process unfolds.

Using Evaluation Models To Clarify Need

How can we address Guba and Lincoln's challenge to deal with the problem of values in the needs assessment process. Evaluation models may offer the instructional developer some useful insights. First, many of the functions that occur in program evaluation also occur in needs assessment. Second, and most importantly evaluators seek frequently to improve what is – a notion that for evaluators consciously implies a value judgement.

Many different evaluation models are described in the literature; nevertheless, a measure of consensus does exist over a number of major evaluation approaches -- some characterized by a single evaluation model and some by several models. Worthen and Sanders (1987) provide a good summary of several of the major evaluation approaches. They identify six basic approaches: objectives-oriented, management oriented, consumer oriented, expertise oriented, adversary oriented, and naturalistic and participant oriented. What follows is a cursory description of each evaluation approach and their possible use in needs assessment.

Objective-oriented Approach

The objective-oriented approach plays a prominent role in the development of educational evaluation. In fact, the field of educational evaluation was initially conceptualized in terms of behavioral objectives and determining a learner's ability to meet these objectives (Worthen and Sanders, 1987). Differences between stated behavioral objectives and observed behavior are seen as symptomatic of deficiencies in the educational innovation being evaluated. Deficiencies would ultimately lead to changes in the innovation in an effort to ensure that eventually the terminal behavior matched the stated objectives of the innovation.

The objective oriented approach probably has the greatest affinity with the problem identification approach presently used in instructional development and hence is not useful in suggesting new ways of problem clarification. As previously mentioned, the prevailing model adhered to by instructional developers during problem clarification seeks to characterize differences between present behavior and desired behavior in terms of behavioral objectives which form the basis for the subsequent design of instructional materials.

In many ways it can be argued that the other evaluation approaches discussed below have been developed in an attempt to address the perceived liabilities of the objective oriented approach. For this reason the subsequent approaches would appear to hold more promise for suggesting new ways of clarifying problems.

Management-oriented Approach

Management oriented approaches, like the CIPP (Context, Input, Process, and Product) model for example, are among the most widely used evaluation approaches. The primary concern of these kinds of evaluations is to provide information that is of use to decision makers. Thus the evaluator begins by clearly identifying the decisions a manager must make and then gathers information that will help the manager make these decisions.

Different kinds of evaluations have been suggested for different kinds of decisions. The CIPP model, for example, describes context evaluations (an evaluation that helps clarify the setting, goals and objectives of an intervention), input evaluations (an evaluation that clarifies procedural and budgetary plans of an intervention), process evaluation (an evaluation that identifies and corrects problems of an intervention while it is in progress), and product evaluation (an evaluation that clarifies whether to continue or modify an existing intervention and to present a clear record of how the intervention works).

Romiszowski (1981) has suggested that the instructional development process is very much like the one laid out in the CIPP model – and that a needs assessment is very much like the "context" evaluation presented in the CIPP model. Certainly, the description of a context evaluation offered by Stufflebeam (1968), sounds very much like what an instructional developer does during a needs assessment:

> Context evaluation would be used when a project is first being planned. The major objective of context evaluation is to define the environment where

change is to occur, the environment's unmet needs and opportunities for change. Information from context evaluation leads ultimately to the establishment of program goals and objectives.

How might a context evaluation be undertaken to ensure that the "value systems of the planning partners and the instructional developer" are identified? It could be argued that a thorough context evaluation is much like an anthropological study – one that does not merely describe a context but a culture which is, by definition, value laden. This idea is not new. An anthropological approach to the study of values in the instructional development process has been put forward by Yeaman, (1990). The methods of the anthropologist may help to identify , describe, and attend to the values of the instructional developer, client, and stakeholder. Such an approach may also give the instructional developer insights into how the needs assessment process itself influences these different value systems.

Naturalistic and Participant Oriented Approach

Naturalistic and participant oriented evaluation approaches squarely place the emphasis of evaluation on describing and understanding, as fully as possible, how an intervention works within a specific context. Not surprisingly, therefore, the methods and tools of the anthropologist and very useful. This approach is in stark contrast to an objectives oriented approach. Understanding is achieved through a pluralistic inductive approach to evaluation. That is, the concerns of key stakeholders rather than decision makers are given particular attention. Also the use of more naturalistic and participant oriented data collection methods is emphasized. First hand experience is highly valued and the existence of multiple realities is readily accepted.

The naturalistic and participant oriented evaluation approaches, in our opinion, maybe especially well suited to problem clarification in instructional development. A naturalistic/participant oriented instructional analysis would be concerned primarily with describing and understanding a particular learning environment. It would place a heavy emphasis upon clearly understanding and being sensitive to the concerns of learners themselves rather than the needs of administrators or managers. Many of the data gathering methods used in such an approach show up in subsequent evaluation approaches. For example, the use of in depth interviews, focus groups, and panel discussions, are endemic to the expertise oriented and adversarial oriented evaluation approaches as well. An naturalistic and participant oriented evaluation approach to needs assessment would also rely heavily upon detailed observations of a settings. These "field notes" would help the developer assess the values of the key players involved in the process.

Expertise-oriented Approach

Arguably the oldest form of evaluation, an expertise-oriented approach relies on the knowledge and wisdom of qualified experts to assess the worth of something. Review panels, professional accreditation committees, movie and theater critics are all examples of evaluations made by an expert or a group of experts. Expert reviews vary widely with respect to the process followed. Some expert evaluations make explicit the criteria used to judge, time lines used in making judgments, conflicting opinions among experts, and the credentials of the experts, while others make none of these points explicit. For example, a panel of supreme court judges would be an example of a case where all of these points are made explicit when the judgement is handed down. A dissertation committee would be a case where little additional information is given as to how a passing or failing grade was determined.

An "expert" needs assessment could be set up in much the same way as an expert evaluation. For example, a panel of experts could be asked to investigate a setting and suggest reasons students or employees are not performing adequately. Expert panels made up of individuals familiar with the setting being studied, could provide valuable information about the context -- internal conflicts, budget constraints etc. Blue Ribbon panels also might give an instructional development initiative added weight and credibility to those involved who may be resistant. An expert panel would also readily allow for a range of input and opinion while giving, possibly, key players a greater sense of ownership in the process. A problem clarification process patterned after a supreme court deliberation may be useful as well. One would be left with several expert views of what the instructional problem or problems might be as well as expert assessments of the value systems of the client and and how these shape a determination of the instructional problems. While an overall decision may be reached, the panel is not constrained to reach consensus. This may encourage multiple points of view and perspectives.

Consumer-oriented Approach

The consumer oriented evaluation approaches were developed so that individuals or agencies could readily assess the relative merit of a product they were planning to buy. Rating checklists are a typical method of undertaking these sorts of evaluations. A set of criteria are created for a particular type of product (criteria for a car might include: horsepower, breaking distance, and cost) . Several examples from a class of products are then compared with respect to these criteria. A consumer either uses the checklist to assesses a product's relative strengths and weaknesses or consults a report where someone else has actually rated a product using the evaluation criteria. The emphasis in this type of evaluation is to communicate in a simple straight forward manner whether a particular product is worth purchasing or not.

A consumer oriented approach to problem clarification suggests a check list of concerns that would be addressed during the instructional development process. This sort of checklist could serve as a starting point in a needs assessment. A properly created checklist might ensure that developers consider a number of different kinds of problems. The most important question in generating a checklist÷ is from where do the checklists come. It seems reasonable that they could come from either the expertise or naturalistic oriented approaches.

Adversary-oriented Approach

Adversary oriented approaches to evaluation attempt to minimize the bias inherent in all evaluations by incorporating planned opposition . By generating opposing points of view around a given issue it is hoped that a clear course of action will emerge. Fairness and balance are the driving forces behind these kinds of evaluations. Typically adversarial evaluations attempt to bring out the pros and cons of an issue; however, some kinds of evaluations, such as committee hearings, deliberately consider several viewpoints. Adversarial approaches, potentially, have much in common with other evaluation approaches such as expertise-oriented approaches because they rely heavily on the use of expert witnesses.

An adversarial form of problem clarification would be especially useful where two or more strongly competing opinions exist. Perhaps the strongest asset of an adversarial form of instructional analysis would be a recognition that different kinds of problems can be justified. It may also provide a forum for the discussion of multiple perspectives on the value systems of key players in the development process.

Summary and Future Research

Clearly the emphasis in this paper has been upon building a case for new approaches to needs assessment. While some practical suggestions have been made as to how a needs assessment may be patterned after a particular evaluation approach, more work needs to be done to make these suggestions more concrete. Certainly, data collection and data analysis procedures used in naturalistic kinds of inquiry such as those carried out by anthropologists should be considered by developers during needs assessments. Also, future work should attempt to assess the use of these new approaches in actual development projects.

References

AECT (1977). *The definition of educational technology.* Association for Educational Communications and Technology. Washington D.C.

Guba, E. and Y. Lincoln. (1981, April). *The place of values in needs assessment.* Presentation at the AERA national meeting, Los Angeles, CA.

Kaufman, R. (1968). A systematic approach to education: derivation and definition. *AV Communication Review, 16* No. 4 (Winter, 1968),415-425.

Kaufman, R. and F. English (1979). *Needs assessment: concept and application.* Educational Technology Publications. Englewood Cliffs, NJ.

Jorgenson, S. (1981). A conceptual analysis of the assumptions and aspirations of instructional development. Unpublished doctoral dissertation. Indiana, University. University Microfilms International. Ann Arbor, MI.

Little, W. (1933). *The Shorter Oxford English Dictionary.* Oxford University Press: London.

Mager, R. (1976). Why I wrote...*NSPI Journal*, 15, No.8 October,1976, 4.

Romiszowski, A.J. (1981). *Designing instructional systems.* Kogan-Page, Publishing: London.

Stufflebeam, D. I. (1968). Toward a science of educational evaluation. *Educational Technology*, 8 (7), 5-12.

Worthen, B. and J. Sanders. (1987). *Educational evaluation: alternative approaches and practical guidelines.* Longman. New York.

Yeaman, A. R. J. (1990). An anthroplogical view of educational communication and technology. Beliefs and behaviors in research and theory. *Canadian Journal of Educational Communication*, 19, 237-246.

Title:

Educational Technology: A Conceptual Study in Metaphor

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Background

One weakness of the field of educational technology, like many academic fields of study, has been the difficulty that many professionals and practitioners have had explaining the meaning of the terminology of the field. The traditional approach is the commonly heard prescription: define your terms precisely. We often do this when we provide an operational definition in our empirical studies. But it is evident that previous attempts at defining are at least partially responsible for the differing viewpoints with which we are faced, and are partly responsible for the difficulty that we encounter when trying to explain the terminology of the field. Foremost among these difficult terms is educational technology.

There have been many attempts to define the term "educational technology" (AECT, 1977). These have proven to be unsatisfactory in the long term, as witnessed by the frequent efforts of the Association for Educational Communications and Technology's Definition and Terminology Committee. Because of the many changes in both concept and practice that occur within the field, the definition must undergo change. It may be more useful to consider using some different techniques of conceptual analysis when investigating the term educational technology.

Rather than focus on one particular definition, this inquiry is intended to study multiple conceptions of the term "educational technology". Several writers have discussed the idea of multiple conceptions of educational technology (cf. Saettler, 1990 and Roundtree,1979). These studies have treated multiple conceptions of educational technology in a linear/historical fashion,arguing that one conception is replaced by another as time passes. However, this paper argues that multiple conceptions of the term "educational technology" exist simultaneously.

Purpose

The purpose of this paper is to analyze the term "educational technology" and to demonstrate that multiple conceptions of it do, in fact, exist simultaneously. This study has four major objectives: (1) to present the importance of conceptual analysis for investigations in the field of educational technology, (2) to demonstrate that the use of 'metaphor' is appropriate for investigating the concept of educational technology, (3) to provide a theoretical framework for the choice of the metaphors: art, craft, science, and engineering as ways of viewing educational technology, (4) to provide instances of each of the four metaphors, art, science, craft, and engineering from the literature of the field of educational technology.

Philosophical Basis and Conceptual Analysis

Concepts regulate and direct our thought. But concepts are not just matters of the intellect. They govern the way in which we function in our daily lives. "Our concepts structure what we perceive, how we get around in the world, and how we relate to other people" (Lakoff and Johnson, 1980 p.3). This means that the concepts that we use, and the conceptual systems which with we think, are at the heart of how we define our everyday realities.

For purposes of this study it means that the way in which an individual holds a particular concept, in this case the concept of educational technology, will help to determine not only how that individual views the field of educational technology but also how that concept guides the individual's actions within the field of educational technology.

Since the conceptions that one holds of educational technology can help determine how professionals view the field and how professionals function within the field, an analysis of how different individuals view the field will contribute to a greater understanding of the field of educational technology. A better understanding of the concept of educational technology should result in the identification of some of the assumptions and presuppositions that help drive the activities of the field of educational technology.

The questions; "Why do educational technologists think and act the way that they do?" and "What might this thought and activity mean for the field of educational technology?" The first question is primarily a historical question, the second is a matter of reflection. These ideas are intertwined and separating them is difficult. As such, both should be considered in any conceptual study.

Historical interest in concepts

Any conceptual study will be historical in some sense for two reasons; first, we can find certain general historical patterns that often appear when studying the development of concepts. Many concepts pass through two periods: one where there seems to be in strong agreement, followed by one where exceptions begin to appear (Fleck, 1979). An example of this in our field is the changes that have occurred in the definitions of the term "educational technology".

A stylistic bond exists between many concepts of an historical period. This is based on the influence that these concepts have upon each other. There is "a thought style which determines the formulation of a concept" (Fleck, 1979 p.9). Perhaps it is more accurate to say that there are different 'thought styles' that co-exist, and that each thought style has some impact on how a given concept is viewed. Different thought styles emerge more dominant at different points in time. The co-existence of different 'thought styles' might explain how concepts can be thought of differently by different groups of people. Historical investigation shows that strong disagreements often occur about the definition of concepts (Fleck, 1979). Conflicts exist in spite of the fact that, from a logical viewpoint, the various conceptions may be equally plausible.

For our field, it means that educational technologists are not at complete liberty to replace a "mass-media" concept of educational technology with one based solely on the idea of the systems approach. There are 'thought styles' that exist that would oppose this attempt. These 'thought styles' may exist within the field of educational technology, or they may exist outside of the field.

Reflective interest in concepts

In addition to historical interest in concepts, there is also reflective interest. "Concepts in education are often used in ways in which they are normative as well as descriptive "(Gusfield, 1975 p.xvii). In this sense, they can be characterized like theories, which have also been classified as being normative or descriptive. Studying concepts can help us to determine the significance of events and processes as well as just describing them. Studying concepts can also reveal the subtle aspects, that is, the emphasis which may be placed on certain words and actions.

A concept might be considered as a sort of instrument, something that serves us. But it can also be thought of as something that we are inclined to serve, either voluntarily or not. The ideas that matter most to people are the ones that give their experience direction and meaning. But frequently this is done at a subconscious level. Lakoff and Johnson, describe this, saying,

> But our conceptual system is not something that we are normally aware of. In most of the little things we do every day, we simply think and act more or less automatically along certain lines. Just what these lines are is by no means obvious. One way to find out is by looking at language. Since communication is based on the same conceptual system that we use in thinking and acting, language is an important source of evidence for what that system is like (1980, p. 3).

The concept of educational technology is interpreted in many ways. The problem of trying to analyze complex concepts is that there is not one singular meaning which can be arrived at. This difficulty can be thought of as a choice between clarity and utility. It would be simpler if one could define the concept and point to what it conveys. This would represent a consistent, uniform meaning, and imply that consensus exists among educational technologists. But this would be misleading and inaccurate. It would not serve those who wish to study the concept of educational technology to grasp the different usages and contexts of that concept. Nor would it help them to understand the reasons why these differences arose. And it would not aid them in their professional need to cope with the ambiguity which is so prevalent in the field of educational technology.

Approaches to conceptual study

There are a number of different ways in which a phrase or term can been studied. These approaches can be classified in three broad categories, those that are historical in nature, those that are associated with sociology, and those having to do with linguistics and philosophy.

Historical approaches

Etymology focuses on the history of the term. Here the meaning of the term is traced back to its earliest roots. Then subsequent definitions and uses of the term are provided. It is sometimes argued that since a term held a certain meaning in the past, that this past meaning, or portions of it, can be carried forward and reintroduced, and used as it had been in the past.

Studies of the history of ideas also describe the changes in the meanings of particular terms over time. As originally conceived, this approach focused on the "root ideas" which constituted a broader concept (Lovejoy, 1940). Often, these root ideas were the conditions, necessary and sufficient, that set the boundaries of a particular concept. It was reasoned that if the essential components of a concept could be understood, then the meaning of a concept would become clear.

Sociological approaches

Max Weber introduced the "ideal-type" as a way to investigate complex concepts. Weber characterizes this as an imagined construction,

> ...not a description of reality but it aims to give unambiguous means of expression to such a description (Weber,1963 p.28).

Gusfield (1975) uses another sociological approach called the "paired opposites". The idea is to study a concept by relating it to its opposite. His study is a discussion of the concepts of community and society. He provides two poles between which real instances can be ranged as being more or less of one type or another. Gusfield claims that "in using type as paired opposites, the sociologist heightens the understanding of each"(p 13).

Approaches from linguistics and philosophy

In the philosophical/analytic approach, writers expose the problems inherent in the most fashionable definitions of a given concept, they identify and criticize possible alternatives, and then put forth their own viewpoint. There are a number of variations on this theme.

The 'dictionary approach' which is, "the determination of current usage from the users of special vocabularies" (Churchill,1968 p.4). There have been many attempts to explain educational technology by "defining" it (AECT,1977). These attempts were not what might be commonly referred to as definitions, relating the meaning of a term in a sentence or two. Rather they were often lengthy, deductive treatments of the author's conception of educational technology. It is important to note that these studies were deductive. By this it is meant that the author started from a single statement about what educational technology was and then proceeded to elaborate on that statement, about what the parts of the definition were and how they fit together. This was called the "complete" definition statement of educational technology. It was a deductive and systematic explanation of the term educational technology.

These definition statements share some commonalties with what many philosophers and social scientists refer to as conceptual analysis. Both are systematic and detailed treatments of complex terms. However, as Gowin (1982) explains:

> Concept analysis, however, is different from simply giving definitions of the meaning of terms. We would not complete an analysis by looking in dictionaries for the meaning of words. Instead, we are seeking a reason or *explanation for why we use* the terms in particular ways (p.200).

This is the key to the so-called "Oxford School of Philosophy" or the "Philosophy of Ordinary Language". It is from this area of study that we have received the famous dictum 'the meaning is in the use'.

Another very popular method of conceptual analysis concerns itself with determining the necessary and sufficient conditions for a particular instance to be part of a larger classification. In this approach, the attributes of a particular concept that are determined to be necessary in order for its existence are established. Then, certain of these attributes, or combinations of attributes, are deemed to be sufficient for an instance to be considered a member of a larger set or category (Lakoff and Johnson,1980 and others). This is often considered to be the 'traditional approach' to analyzing concepts.

Still another approach to understanding the meaning of a concept is through the study of metaphors. A metaphor, Egon Guba writes,

> ...is a figure of speech in which the meaning of a term or phrase is transferred from the object it ordinarily designates to another object so as to provide new insight or perspective on the latter. In a broader sense, the term metaphor may also designate a process whereby the meanings and relationships of one theory or model may be used to suggest meanings or relationships in another arena (Guba,1978 as cited in Smith, 1982 p.52).

Studying Metaphors

Studying metaphors is recognized as important to the study of literature. Lakoff and Johnson (1980) identify other focal points for metaphorical study;

> Metaphor is for most people a device of the poetic imagination and rhetorical flourish-a matter of extraordinary rather than ordinary language. Moreover, metaphor is typically viewed as characteristic of language alone, a matter of words rather than thought or action (p.3).

There are many different views of metaphor. There are the substitution, semantic and comparison views. There is the interactionist theory of metaphor. There is the pragmatic approach to metaphor. And there is the literal vs root metaphor controversy. These have been classified along a constructivist-nonconstructivist line (Ortony,1979). In the constructivist tradition, Lakoff and Johnson (1980) discuss a variety of "root metaphors" for analyzing conceptual structures. One such example is the "argument is war" metaphor;

> Your claims are indefensible
> He attacked every weak point in my argument
> his criticisms were right on target
> I demolished his argument
> I've never won an argument with him
> You disagree? Okay shoot
> If you use that strategy, he'll wipe you out
> He shot down all of my arguments.
> (Lakoff and Johnson,1980 p.4)

Driscoll (1990) describes the usefulness of using the constructivist approach to metaphor in educational technology, especially within the area of instructional design. Driscoll suggests that using metaphor is a way to identify the assumptions on which instructional design is based.

But one must use caution when employing metaphors. One may select good ones or poor ones and it is often difficult to know the difference without proper criteria (Smith,1981). Further, when used without proper consideration, they can be misleading and inaccurate (Schon,1979).

The use of metaphor to investigate educational technology is not unique to this study (cf. Hlynka & Nelson, 1991 and Driscoll 1990). Hlynka and Nelson (1991) have discussed the metaphors of the term "educational technology". They constructed these "root metaphors" by identifying patterns of language used in the literature of the professional literature.

But there is another aspect to metaphor. It is the figurative side. It is a more traditional approach to the study of metaphor. It involves the overt characterization of educational technology. Sometimes these characterizations are conscious decisions and sometimes they are not. Regardless of the intent of the intent these decisions, these characterizations have a theoretical bases that is historically rich.

If care is taken 'metaphorical study' is a viable form of conceptual study for investigating educational technology. It is one way of getting at the concepts and assumptions that exist within the reality of professional practice. The purpose of "exposing metaphors, and the corresponding myths from which they're derived, frees us to consider alternative ones" (Driscoll, 1990 p.33) and thereby laying the groundwork to change practice.

It is the study of metaphor in terms of "common language" and its relation to thought and action which is central to this study. Here, the investigation of metaphor will focus on characterizations of the practice of educational technology.

On technology

Most people involved in the field of education are familiar with the concepts of "education" and "technology" long before they realize that the two concepts together make up a specific field of study. When combined, these two words take on a new meaning, one which is multifaceted and dynamic.

Considering the many ways in which "educational technology" has been conceptualized, the question arises,"which ones would be most helpful in the study of educational technology?" A historical overview might be helpful.

Many of the studies that are conceptual treatments of "educational technology" include a definition or a discussion of the term technology'. Far fewer of these studies include a definition or discussion of the terms 'education' or 'educational'. One could infer several things from this: (1) that the word education is understood, (2) that technology is the dominant or more important word in the phrase educational technology, (3) that the word 'educational' in the phrase educational technology is a descriptor modifying the purpose of the technology, such as in 'educational television'.

Two of the most frequently cited definitions of technology that are included in conceptual treatments of educational technology are:

> "Technology means the systematic application of scientific or other organized knowledge to practical tasks" (Galbraith,1967 p.24 as cited in AECT, 1977, p.57; Silber,1972, p.36 and Heinich,Molenda,and Russell, 1989, p.24).
>
> "Technology includes processes, systems, management and control mechanisms, both human and non-human, and above all... a way of looking at problems as to their interest, and difficulty, the feasibility of technical solutions, and the economic values-broadly considered-of those solutions." (Finn, in Eboch, 1963, p.17 as cited in AECT, 1977, p.57 and more completely in Ely, 1970, p.85)

A problem with the first definition is the attempt to separate the types of knowledge that are identified. Is "scientific knowledge" not "organized knowledge"? Practically speaking, the definition of technology would read: 'Technology is the systematic application of organized knowledge to practical tasks'. Perkins (1986) argues that, in fact, it is the design or organization of information which makes it knowledge. If this is true than "technology is the application of knowledge to practical tasks." To follow this line of reasoning one would have to ask "what would one apply to practical tasks if not knowledge?" The answer is not clear.

The second definition, while certainly less succinct than the first, is important because it identifies many of the component characteristics of technology. However, this particular definition has a context or interest attached to it. Finn was a proponent of making the field a profession and changing the name of the field to include the word technology. It is not a coincidence that he defined technology to include many of the functions which he believed to be important to professionalizing the audiovisual field (Finn,1953). This suggests that this definition of technology is "loaded" and not appropriate for use in this study.

In a lengthy conceptual study of educational technology W. Kenneth Richmond (1970) examines definitions of words that he argues are the historical basis of the term "technology". He includes the following:

> Technical-Belonging to arts, not in common popular usage.
> (John Walker, *A Critical Pronouncing Dictionary of the English Language, New Edition*, carefully revised, corrected and enlarged, Nelson, 1845.)
>
> Technical-Of or in or peculiar to a particular art or science or craft (t. terms, skill); of or in or the mechanical arts (t.education, school). technicality-being t.,a t.term: technics-doctrine of the arts, technique; technique-manner of artistic execution, the part of artistic work that is reducible to formula, mechanical skill in art.[Gk tekhne art]
> (H.W.Fowler and F. G. Fowler compiled, *The Pocket Oxford Dictionary of Current English, Third Edition,* Oxford at the Clarendon Press, 1939)
>
> Technic-1.= foll.2.= technique (usu.pl) doctrine of arts in general: (pl.) technical terms, details, methods,etc. Hence technician-person skilled in the technique of a particular art, or in arts generally.[Gk tekhnikos (tekhne art,)]
>
> Technical-Of or in a particular art, science, handicraft, etc., as terms, skill, difficulty; of, for in, the mechanical arts, as education, school; legally such, in the eyes of the law, as assault.
>
> Technique-Mode of artistic execution in music, painting, etc: mechanical skill in art.[F,as technic]
>
> Technology-Science of the industrial arts; ethnological study of development of arts.[Gk tekhnologia (tekhne art -logy)]
> (H. W. Fowler and F. G. Fowler (eds.), Concise Oxford Dictionary of Current English, Fourth Edition, Revised by E. McIntosh, Oxford at Clarendon Press, 1951)

Richmond points out that these are related terms and that the list of these related terms has grown tenfold in the period from 1845 to 1951.An undated listing of these terms, from the Oxford English Dictionary (1989) includes:

technic-of or pertaining to art,or craft
A 1.Pertaining to art or an art;
2. Skillfully made or constructed
B. 1.A technical term, expression, point, or detail; a technicality
2. a Technical details or methods collectively; the technical department of a subject; the formal or mechanical part of art.
b. Collective pl. technics in same sense; also construed as a singular.
3. The science or study of art or arts, esp. of mechanical or industrial arts

technical-A.1 Of a person; Skilled in or practically conversant with some particular art or subject.
2. Of a thing ; Skillfully done or made
3. a. Belonging or relating to an art or arts; appropriate or peculiar to, characteristic of, a particular art, science, profession, or occupation; also, of or pertaining to the mechanical arts and applied sciences generally.
b.said of words, terms, phrases, etc., or their senses of acceptations
c.Of an author, a treatise, etc: Using technical terms: treating a subject technically.
d.Technically so called or regarded; that is such as a technical point of view
4. Of, pertaining to, or designating a market in which prices are determined chiefly by internal factors

Technically-In a technical manner; in relation to the arts and applied sciences, or to a practical art or subject; according to technical methods.

Technician-a. A person conversant with the technicalities of a particular subject. b. One skilled in the technique or mechanical part of an art, as music, or painting. c . A person qualified in the practical application of one of the sciences or mechanical arts; now esp. a person whose job is to carry out practical work in a laboratory or to give assistance with technical equipment.

Technicism-1. A technical term or expression, a technicality.
2. Technical quality or character; a condition in which practical results or methods are stressed.

Technicize-To make technical; to subject to a high degree of technicality

Technification-The adoption or imposition of technical methods.

technique-a. Manner of artistic expression execution or performance in relation to formal or practical details (as distinct from general effect, expression, sentiment, etc.); the mechanical or formal part of an art, esp. of any of the fine arts; the manner of execution or performance in any discipline, profession, or sport; also, skill or ability in this department of one's art; mechanical skill in artistic or technical work. loosely a skilful or efficient means of achieving a purpose; a characteristic way of proceeding; a knack.

> Technological-1. Belonging to technical phraseology or methods.
> 2. Relating to or dealing with the study of the arts, esp. the industrial arts.
> 3. Pertaining to or characterized by technology; resulting from developments in technology.
>
> Technology-systematic treatment 1.a. A discourse or treatise on an art or arts; the scientific study of the practical or industrial arts. b. Practical arts collectively. c. A particular practical or industrial art.
>
> (*Oxford English Dictionary,1989*)

The definitions of words related to technology, like the definitions of educational technology, include many words and phrases that are repeated, or rather, held constant. Some of these repeated words and phrases are: "art", "artistic execution", "craft", "systematic study", "scientific study", "science", "mechanical skill", "method", "mechanical arts", "industrial arts", "practical arts", and "applied science".

The last four of these, "mechanical arts", "industrial arts", "practical arts", and "applied science" are all associated with 'engineering'. The remaining words and phrases may all be subsumed by the words "art", "science", and "craft".

There are four views of technology that come close to representing it as art, science, craft, and engineering. These essays were produced by Martin Heiddegger (1977), Jacques Ellul (1963), Victor Ferkis (1969), and William Barrett (1978). Heiddegger (1977) writes for a technology that is art;

> Technology is therefore no mere means. Technology is a way of revealing. If we give heed this, then another whole realm for the essence of technology will open itself up to us. It is the realm of revealing, i.e.,of truth.
>
> This prospect strikes us as strange. Indeed, it should do so, should do so as persistently as possible and with so much urgency that we will finally take seriously the simple question of what "technology" means. The word stems from the Greek. Technikon means that which belongs to techne. We must observe two things with respect to the meaning of the word. One is that techne is the name not only for the activities and skills of a craftsman, but also for the arts of the mind and the fine arts. Techne belongs to bringing-forth, to poiesis; it is something poietic (Heidegger,1977 p.12-13).

Writing for a technology that may be characterized as more craft oriented Ellul (1963) focuses on the word technique. He writes:

> In fact, technique is nothing more than means and the ensemble of means...Techniques considered as methods of operation present certain common characteristics and certain general tendencies...The technical operation includes every operation carried out in accordance with a certain method in order to attain a particular end (Ellul,1963 p.19).

Ferkis (1969) criticizes Ellul's notion of technique and writes for a technology that is more an engineering concept argues:

> In so broadly conceiving technology there is obviously the danger of falling into the trap of Ellul and other writers for whom technology is technique and everything is technique and therefore all human actions are technological. We can avoid this pitfall if we think of technology as a self-conscious organized means of affecting the physical or social environment, capable of being objectified and transmitted to others, and effective largely independently of the subjective dispositions or personal talents of those involved. Thus an opera singer exhibits "technique" but is not really utilizing a technology (Ferkis,1969 p.37-38).

"Technology is embodied technique" (Barrett, 1978 p.18). A technique is a standard method that can be taught. Continuing his discussion of the inseparability of technology and science Barrett argues that:

> It is method, and the dominance of method that marks the chief difference between modern science and the science of the Greeks. It is an attempt to control and predict phenomena rather than submit to its existence that differentiates between the two. Modern science could be considered as a movement from theory into practice with method at the core of the discussion. The individual (knower) no longer merely observes what is. Rather, the individual sets the conditions, asks the questions and elicits the answers. The meanings of the questions and answers themselves become less separable in the conditions established by the new science. Technology is not the application of the new science it is the heart of the new science (Barrett,1978 p.).

An analysis of these definitions and conceptual discussions reveals that technology is seen in different ways but there is a common theme that runs through them. The theme is that technology is a *process*.

Art, Craft, Science and Engineering in Education

A study of the history of education over the last one hundred years reveals that education, and many of the concepts that are associated with education, are often characterized as art, science, craft, and engineering. Philosopher John Dewey has, to some degree, characterized education in all four of these veins.

Among his many and varied writings Dewey examines education as an art (Dewey, 1928 1929a) as a science (Dewey, 1928, 1929b), and as Engineering (Dewey, 1929c). In a discussion of the relationship of art. science, and engineering to education Dewey (1929b) writes:

> That, in concrete operation, education is an art, either a mechanical art or a fine art is unquestionable. If there were an opposition between science and art, I should be compelled to side with those who assert that education is an art. But there is no opposition, although there is a distinction. We must not be misled by words. Engineering is, in actual practice, an art. But it is an art that progressively incorporates more and more science into itself, more of mathematics, physics and chemistry. It is the kind of art it is precisely because of a content of scientific subject-matter which guides it as a practical

> operation. There is room for the original and daring projects of exceptional individuals. But their distinction lies not in the fact that they turn their back on science, but in the fact that they make new integrations of scientific material and turn it to new and previously unfamiliar and unforeseen uses. When, in education, the psychologist or observer and experimentalist in any field reduces his findings to a rule which is uniformly adopted, then, only, is there a result which is objectionable and destructive of the free play of education as an art.
>
> But this happens not because of scientific method but because of departure from it. It is not the capable engineer who treats scientific findings as imposing upon him a certain course which is to be rigidly adhered to: it is the third- or fourth-rate man who adopts this course. Even more, it is the unskilled day laborer who follows it. For even if the practice adopted is one that follows from science and could not have been discovered or employed except for science, when it is converted into a uniform rule of procedure it becomes an empirical rule-of-thumb procedure-just as a person may use a table of logarithms mechanically without knowing anything about mathematics (Dewey, 1929, p.635-636).

It must be acknowledged that in the early part of the twentieth century 'science' often held a meaning that is substantially different then the meaning that is ascribed to it today. However, because of the influence that Dewey has had on the field of education, later scholars adopted his language in new contexts. This adoption of language without accounting for changes in popular meaning has led to confusion within the field of education in general, and also in the field of educational technology.

Contemporaries of Dewey have also used the words art, science and engineering to discuss education and concepts that are related to it. William Heard Kilpatrick (1925) argues that education is an art. E. L. Thorndike (1913) promotes a view that education is a science. Franklin Bobbitt refers to "educational engineers" (1912).

Individuals writing after the era of progressive education had come to a close, continued discussing education and some of its related concepts as art, science, and engineering. Gilbert Highet (1958) referred to teaching as an art. W.W. Charters (1945) discusses educational engineering. B.F. Skinner (1954) argues for a science of learning.

The idea of craft is noticeably missing from the previous discussion. Perhaps this was due to the growing acceptance of "scientific-method" during the early portion of the twentieth century. Science, as a modern concept, would have been seen in opposition to craft which may have been taken as outmoded.

It is in the era of post-progressive education that the word craft gains popularity in the education literature (cf.Thom, Blumberg). This may be due to a backlash against scientific and engineering approaches to education. It may also be due to the acceptance of certain contributions of science to the field of education. The use of scientific knowledge in the field of education has become more refined. It has become clearer that science contributes to the development of educational procedures and not to the setting of educational goals (Kliebard,1986). One could infer from this that scientific based procedures alone are insufficient for completing the educational enterprise. As such, the idea of craft, because it can include these scientific procedures, gains in popularity.

The idea that, both, technology and education has been viewed as art, science, engineering, and craft has been with us for for a long time. Therefore, it seems appropriate that these four words or interpretations of technology and education: art, science craft, and engineering, will be the interpretations that are used to analyze educational technology in the remainder of this study.

Art, craft, science and engineering in educational technology

The words art, craft, science, and engineering are not new as descriptors of educational technology. Educational technology has been characterized as being an art by Hylenka (1991), Bass and Dills (1984), and Davies (1984). It has been called a craft by Finn (1953) and Driscoll (1990) and a science by Lumsdaine (1964) and Reigeluth (1983). It has also been called engineering by Bern (1961), Szabo (1968), and Heinich (1984).

The words art, craft, science and engineering are really quite familiar to the literature of educational technology. But an analysis of these familiar and obvious connotations shows that they are not easily distinguishable from one another. And seldom are the reasons for using these characterizations and their implications made explicit by their users in our field.

Science

The characterization of educational technology as a science is over thirty years old. In an article relating technology to education Finn (1960) chose not to distinguish between science and technology.

> For purposes of this paper, no distinction is made between "science" and "technology" or between "pure" and "applied" science (Finn,1960 p.84).

A discussion of the distinction between science and technology would certainly have been helpful to Finn's readers, but it was not central to the thesis of the paper. But by not making the distinction Finn contributes to the confusion and ambiguity of the concept.

Lumsdaine (1964) outlines the premises and importance of a science of instruction. There are three ideas that are central to the existence of a science of instruction: 1) the desire to generate rules which can be generalized beyond specific situations, 2) the generating and testing of hypotheses, 3) the use of experimental techniques. Lumsdaine writes:

> The attempt to develop instructional materials not only to serve as a vehicle for testing hypotheses but also to attain a high degree of instructional effectiveness tends to generate provisional "rules" for effective programming of instruction, which can be implemented in experimental materials even though these rules are not tested directly within the confines of a given programming project. Such working guidelines need to be translated into hypotheses that can be subjected to experimental test if a genuine science of instruction is to evolve (Lumsdaine, 1964 p.400).

He concludes:

> Finally, it may well be re-emphasized that the differences in present conceptions and forms of programming as well as their current theoretical rationales, are less important than the basic conviction that instruction is amenable to systematic description and improvement through experimental inquiry (Lumsdaine, 1964 p.401).

The science conception of educational technology holds that it is an area of study (instruction) which should be investigated by the use of methods and techniques (experimental) associated with the traditional sciences. The goal is to be able to prescribe interventions (actions) to bring about desired outcomes.

Engineering

The idea of problem solving is crucial to an engineering conception of educational technology. Discussing the method of the educational engineer, W. W. Charters (1945) writes:

> First, the educational engineer accepts an idea to develop, a problem to solve, or a question to answer....Having accepted an idea to work upon, his next step is a logical definition of the problem....He must know precisely what he is supposed to do. When a problem has been defined, the educational engineer analyzes it to discover the factors that must be considered. Each of the factors requires analysis that must be considered. Thereupon, the assignment is planned. His attention is engrossed in the methods to be used to control the factors. He concentrates upon the "how" of his project; he decides that he will define the objectives in this manner, make his selection of words in that fashion, and determine the related characteristics in another way. These specifications he formulates with the greatest of care because upon their excellence rests the success of his project.
>
> Having completed his plans, he proceeds to construct his project by carrying out the operations which have been specified in the manner decided upon. The labor of construction consumes the major portion of the time spent upon a project although their plan is the most critical step in program building. When the instrument has been constructed, operation follows. Planning and construction have been carried on to that end. The idea has been given body on the assumption that, when properly implemented, it will improve instruction. The problem has been solved with the expectation that its solution will increase the efficiency of school processes.
>
> The final phase of the engineering method in education is evaluation. When the operation is completed, it is tested to see if it fulfills its function adequately. If it does, it continues to be used. If it does not, it may be discarded. But if the idea is properly treated in the early stages of the engineering process, evaluation and testing result in further improvements in the program rather than its rejection (Charters,1945, p.36-37 & 56).

Heinich (1984) accepts the premise that educational technology is basically an engineering view. He argues that educational technology is an applied field which is concerned with means and ends.

> Instruction is the management of learning, and instructional management, like engineering, is a class of its own made up of a complex organization of men, machines, and processes (p.84).

But, Heinich also challenges the scientific conception of educational technology.

> A large-scale instructional problem may not be best analyzed in terms of individual personalogical variables or isolated media attributes but by a consideration of demographics of students, organizational relationships, the sociology of the instructional environment, delivery systems, etc. The laboratory approach of many of our researchers frequently is not compatible with instructional management realities.
>
> We need to remember that research techniques designed to establish cause-and-effect relationships may not be suitable for means-ends problems. Research designs and statistical techniques most appropriate for conclusion-oriented research may impose artificial and unrealistic constraints on decision-oriented (situation-specific) questions....The techniques of operations research in engineering and business administration are more "sympatico" with decision-oriented problems in instructional systems.
>
> We have emulated science in our research for too long. There are many reasons for this, a few implied earlier, but surely the higher status accorded science over technology in higher education and the virtual adoration of SCIENCE by the public are important factors (Heinich, 1984, p.84).

Critics of educational technology often treat the engineering and the science conceptions of educational technology as if they were the same. No doubt there are some similarities, and there are many cases where such a categorization scheme is justified. But certainly an engineering conception of educational technology differs substantially from a science conception. The science conception focuses on prescriptions derived from experimental methods, the engineering conception on problem solving and applications that include more considerations than the experimental method.

Art-then Craft

Davies (1991) dissects the concepts of craft and art as they relate to instructional development.

> Admitting the role of art, craft, and science in instructional development, however, is not the same as suggesting that ID, itself, is a craft or science. Indeed, instructional development is very definitely an art. There have been, however, many attempts to make it a craft, while arguing it is a science. It is ironic that when developers highlight the design, development, implementation and evaluation stages-in the belief that these somehow confer the status of scientific endeavor-they are, in fact, reinforcing the craft side of what is essentially a creative act of inquiry.
>
> Attempts to make instructional development a craft or a science have supplied in the first case a heuristic, and in the latter case a recipe or algorithm, that has largely failed to realize the potential of ID. To a certain extent, the problem arises from a misunderstanding of the nature of art, craft, and science. So has the equation of science with technology....
>
> Art and craft are often confused. They are usually seen as somewhat similar, the one shading the other. Science, on the other hand, is perceived as an entirely different process, probably because of its strong empirical

> basis. The distinctions, however, in reality are much more subtle than they appear. It is easier to distinguish between art and craft (Davies,1991 p.96).
>
> The distinctions between art and craft Collingwood (1938) argues in *Principles of Art* are best seen from the perspective of certain key characteristics. They include:
> - Distinctions between means and ends.
> - Distinctions between planning and implementation.
> - Distinctions between raw material and finished product.
> - Distinctions between form and matter.
>
> In essence, if the distinctions are maintained in an activity, Collingwood argues that a craft is involved. If the distinctions are largely absent, blur, or coexist with the other, then an art is at work (Davies, 1991, pp.97-98).

Later Davies discusses the criteria for successful instructional development. They are phrased in the form of questions.

> Are the end results (sensitivities, values, attitudes, skills, knowledge) worthwhile?...
> Have the understandings, attitudes and skills essential to mastery been acquired?...
> Have the learnings been integrated into people's lives, so that reliable performance is achieved?...(Davies, 1991 p.102-103).

Davies argues, with a blend of passion and reason, that instructional development should be treated as an art. He differentiates the concepts of systematic and systemic. Systematic is associated with craft and systemic with art. The crux of the argument is that systematic infers separate stages in a process, that means and ends are separate. Systemic infers that there are not necessarily separate stages in instructional development, that they can co-exist.

There is some confusion in this overall argument. One the one hand Davies states: "Indeed, instructional development is very definitely an art (p.96)." This can be taken to mean that if one is 'doing' instructional development one must be engaged in art. However, the subsequent discussion and reasoning about the systematic-systemic difference leaves the impression that instructional development can be either an art or a craft.

An implication

What does this mean for the field of educational technology? Here, the discussion will be limited to implications for professionalism. Finn (1953) argues that

> ...a profession has, at least, these characteristics: (a) an intellectual technique, (b) an application of that technique to the practical affairs of man, (c) a period of long training necessary before entering into the profession, (d) an association of the members of the profession into a closely-knit group with a high quality of communication between members, (e) a series of standards and a statement of ethics which is enforced, and (f) an organized body of intellectual theory constantly expanding by research (Finn,1953 p.7).

Finn then explains the importance of the sixth criteria:

> ...the most fundamental and most important characteristic of a profession is that the skills involved are founded upon a body of intellectual theory and research. Furthermore, this systematic theory is constantly being expanded by research and thinking within the profession. As Whitehead says, "...the practice of a profession cannot be disjoined from its theoretical understanding or vice versa...The antithesis to a profession is an avocation based upon customary activities and modified by the trial and error of practice. Such an avocation is a Craft...." (16:557) The difference between a bricklayer and the architect lies right here (Finn,1953 p.8).

Finn's intent was to move the audio-visual field from a status of lowly craft to that of a profession. The field of educational technology has long labored under Finn's influence in regards to professionalism. The Association for Educational Communications and Technology (AECT, 1977) has reiterated these conditions for being a profession.

But does this explanation hold up in its entirety? Another way to view "the trial and error of practice" is to call it evaluation. Evaluation, or some like term (criteria check, testing), is a concept that is key to all of the conceptions of educational technology that have been discussed. If this is the lone criteria for craft status, then educational technology is a craft. Educational technologists should be pleased to be thought of as doing a craft, but many are not. Likely this is due to historical considerations. As stated above, craft was seen as something below science, art, and engineering.

One possible way around this difficulty is to consider Pratte and Rury's (1991) discussion of professionalism. They argue that "professionalism...is an ideal to which individuals and occupational groups aspire, in order to distinguish themselves from other workers (p.60)." Pratte and Rury focus on teaching, they call it a craft-profession. They claim

> ...a craft-profession does not rest on a highly formal or codified body of knowledge. Instead, competence for craft-professionals is defined in terms of various skills and practices, reflecting a different sort of knowledge base...much of their knowledge is embodied, something that they learn by doing and that is experientially learned, rather than acquired in a systematic, highly formal fashion (p.62).
>
> To a large extent the distinction between the conceptual (formal) knowledge characteristic of the expert professions and the embodied (experiential) knowledge of the crafts is too finely drawn, perhaps even artificial, as all occupations require both formal and experiential knowledge. It appears that the fundamental point is one of identifying the extent to which a given occupation is dominated by one or the other (p.63).
>
> the concept of craft seems to belong to both the world of skill and the world of calling or profession. The ordinary language appeal of the term is to some shared understanding of what a craft is, to a union of technique and theory. One can, we suppose, be too scrupulous about the matter, but the concept of craft should be understood as an art or skill in a field or calling having appropriate standards-in short, action willingly engaged in accord with publicly agreed on criteria (p.63).

Certainly language can be 'overly scruitinized'. But it seems that discussions of educational technology as Art, Craft, Science and Engineering do shed light on how users of these terms view educational technology as a field of study and as a profession. It seems that sometimes the use of these terms is conscious and sometimes it is not. Sometimes it is an attempt to gain prestige, sometimes it is an attempt to avoid using a word, and sometimes it is simply an attempt to communicate an idea.

Conclusion

It appears as if there are different ways in which educational technology can be characterized. At first glance, one might think that all design is science, development is craft, and all management functions are engineering. But, the reality is that this view is simplistic. It is much more complicated than that. What the analysis in this paper seems to show is that the four characterizations of the term 'educational technology' do currently exist in our field and they have been present for some time.

References

Association for Educational Communications and Technology. (1977) *The definition of educational technology*. Washington, DC: AECT,1977.

Barrett, W. (1979). *The illusion of technique*. Garden City, NY: Anchor Books.

Bass, R. K. and Dills, C. R. (1984). Instructional Development: Art? Science? or Both? In R. K. Bass and C.R. Dills (Eds.) *Instructional Development: the state of the art,II*. pp. 1-6. Dubuque, Iowa: Kendall/Hunt Publishing Company.

Bern, H. (1961). Audiovisual "engineers?" *Audiovisual Communications Review*, 9, 186-194.

Bobbitt, F. (1912). The elimination of waste in education. The Elementary School Teacher, 12 (6),.259-271.

Charters, W. W. (1945). Is there a field of educational engineering? *Educational Research Bulletin*., 24 (2), 29-37,&53.

Churchill, R. (1969). *Recreation: a conceptual analysis*. Unpublished doctoral dissertation. University Microfilms Int.

Collingwood, R. G. (1938). *The principles af art*. Oxford: Clarendon Press.

Davies, I. (1984). Instructional Development: Themata, archtypes, paradigms and models. In R. K. Bass and C.R. Dills (Eds.) *Instructional Development: the state of the art, II*, 8-17, Dubuque, Iowa: Kendall/Hunt Publishing Company.

Davies, I. (1991). Instructional development as an art: one of the three faces of ID. In D. Hlynka and J. C. Belland (eds.) *Paradigms regained: the uses of Illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology*, 93-106, Englewood Cliffs, NJ: Educational Technology Publications.

Dewey, J. (1928). Progressive education and the science of education. In R. D. Archambault (ed.) *John Dewey on education: selected writings*, 182-192. New York: Modern Library.

Dewey, J. (1929 a). The art of education. In J. Ratner (ed.) *Intelligence in the modern world: John Dewey's Philosophy*, 605-606 New York: Modern Library.

Dewey, J. (1929 b). Education as a science. In J. Ratner (ed.) *Intelligence in the modern world: John Dewey's Philosophy* .631-640, New York: Modern Library.

Dewey, J. (1929 c). Sources of a science of education. In J. Ratner (ed.) *Intelligence in the modern world: John Dewey's Philosophy*, 640-654, New York: Modern Library.

Driscoll, M. (1990). Guest Commentary. *Educational Technology*.

Ellul, J. (1967). *The technological society*. Toronto, Canada: Vintage Books.

Ely, D. P. (1970). Toward a philosophy of instructional technology. *British Journal of Educational Technology*.

Eraut, M. (1985). Conceptions of educational technology. In M. Eraut (ed.) *International encyclopedia of educational technology*. Pergamon Press. London.

Ferkiss, V. C. (1969). *Technological man: The myth and the reality*. New York: Mentor Books.

Finn, J. D. (1953). Professionalizing the audio-visual field. *Audio-Visual Communications Review,* 1 (1), 6-17.

Finn, J. D. (1960). A new theory for instructional technology. *AV Communications Review*. 8, 84-94.

Fleck, L. (1979). *The genesis and development of a scientific fact*. Chicago. The University of Chicago Press.

Gowin, D.B. (1981). Philosophy. In N. Smith (ed.) *Metaphors for evaluation*. Sage: Beverly Hills.

Gusfield, J. R. (1975). *Community: a critical response*. New York: Harper Colophon Books.

Habermas, J. (1971). *Knowledge and human interests*. Beacon Press. Boston, MA.

Heiddegger, M. (1977). *The question concerning technology and other essays*. (Translated by William Lovitt). New York: Harper Torchbooks.

Heinich, R. (1984). The proper study of instructional technology. *Educational Communications and Technology Journal*., 32 (2), 67-87.

Heinich, R., M. Molenda and J. Russell. (1989). *Instructional Media*. Macmillan, New York.

Highet, G. (1958). *The art of teaching*.

Hlynka, D. and Nelson, B. (1991). Educational technology as metaphor. In D. Hlynka and J. C. Belland (eds.) *Paradigms regained: the uses of illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology,* 107-119. Englewood Cliffs, NJ: Educational Technology Publications.

Kilpatrick, W. H. (1925). *Foundations of method*. New York: Macmillan Press.

Kliebard, H. M. (1987). *The struggle for the American curriculum 1893-1958*. New York and London: Routledge and Kegan Paul.

Lakoff, G. and M. Johnson. (1980). *Metaphors we live by.* University of Chicago Press. Chicago IL.

Lovejoy, A. (1940). *Essays in the history of ideas.* John Hopkins Press: Baltimore.

Lumsdaine, A. (1964). Educational Technology, Programmed Learning, and Instructional Science. In E. Hilgard (ed). Theories of learning and instruction. The Sixty-third Yearbook of the National Society for the Study of Education. University of Chicago Press. Chicago, Il.

Ortony, A (ed.) (1979). *Metaphor and thought.* Cambridge University Press: Cambridge.

Oxford English Dictionary (1989). Second Edition. Clarendon Press: Oxford.

Perkins, D. N. (1986). *Knowledge by design..* Lawrence Erlbaum Assoc. Hillsdale, NJ.

Pratte, R. and J. Rury. (1991). Teachers, professionalism, and craft. *Teachers College Record.* 93 (1), 59-72.

Reigeluth, C.M. (1983). Instructional Design: What is it and why is it? In C.M. Reigeluth (ed) *Instructional-Design theories and models: An overview of their current status.* Lawrence Earlbaum Assoc. Hillsdale, N.J.

Richmond, K.(ed.) (1970). *The concept of educational technology: A dialogue with yourself.* Weidenfeld and Nicolson: London

Rountree, D. (1979). Conceptions of educational technology. Paper presented at the 1979 Conference of European Educational Technology, 1-12.

Saettler, P. (1990). *The evolution of American educational technology.* Englewood, CO: Libraries Unlimited, Inc.

Silber, K. (1970). What field are we in, anyhow? *Audiovisual Instruction. 15,* (5),.21-24.

Skinner, B. F. (1968). *The technology of teaching.* New York: Meredith Corp.

Smith, N.(ed.). (1981). *Metaphors for evaluation.* Sage: Beverly Hills.

Szabo, W. (1968). Introduction to Audio-Visual Engineering. *Audiovisual Communications* , June.

Thorndike, E.L. (1913). *Educational Psychology.* Macmillan Co. New York.

Weber, M. (1963). The ideal type. In S. M. Miller (ed.) *Max Weber: selections from his work.* (pp. 27-31). New York: Thomas Y. Crowell Company.

Title:

Media Competencies for Pre-Service Secondary Education Teachers: Teaching Discipline and Competency Selection

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MEDIA COMPETENCIES FOR PRE-SERVICE SECONDARY EDUCATION TEACHERS: TEACHING DISCIPLINE AND COMPETENCY SELECTION

INTRODUCTION

> "...studies show that even though teachers have a high level of media competence and equipment is available to them in their buildings, the majority of teachers do not make extensive use of educational media." (p. 60)
>
> C. Edward Streeter

Perhaps one of the reasons teachers do not use media extensively is due to the lack of instruction relative to effective use as it relates to specific disciplines. Knowing about media or knowing that it exists is not the same as knowing how to apply it to enhance the instructional needs of a particular discipline. Experienced or inservice teachers at the secondary level have an understanding of what works well for them. The intent of this study was to draw upon that experience by having inservice teachers recommend instructional media competencies that are beneficial to them in their disciplines.

Proctor (1983), reviewed the available literature relating to media use and found a difference between pedagogical theory and classroom practice. "The prescriptive literature, based largely on the results of empirical studies, outlines the benefits attributable to the use of media; but the descriptive literature, based largely on the results of surveys and questionnaires, reveals one almost universal theme: MEDIA ARE SELDOM USED."(p. 5) An analysis of several media research reviews such as Lumsdaine (1963), Saettler (1968), Levie and Dickie (1973), and Wilkinson (1980) supports the differences between research conducted to determine potential contribution to the teaching/learning process and those which identify or determine the current conditions of use within the classroom.

One application of the descriptive type research is significant in relation to the Teacher Education Programs in the Schools and Colleges of Education. Starting as early as 1932, attempts have been made to identify what is being taught in the media courses offered in Teacher Education Programs. Stracke (1932), Starnes (1937-38), Taylor (1942), de Kieffer (1948, 1959, 1970, 1977), Meierhenry (1966), Rome (1973), McCutcheon (1984) and others have attempted to provide an understanding of curriculum content of media courses. Some like Stracke (1932), Starnes (1937-38), de Kieffer (1948, 1959, 1970, 1977), and McCutcheon (1984) have reviewed the course content of media courses within the schools and colleges of education. While others, Taylor (1942), deBernardis and Brown (1946), Fulton and White (1959), Rome (1973), Lare (1974), Jones (1982), etc., have considered media skills or competencies in use or recommended by inservice education personnel including classroom teachers, administrators and college instructors for methods courses as well as instructional media faculty. These studies make suggestions, either implicit or implied, regarding instructional media course content based on feedback obtained from users.

Reconciling the descriptive and prescriptive research has long been a problem as evidenced by Fulton (1960): "Research evidence indicates that we know much more about what we should be doing with modern communicative media in education than we are actually doing."$_{(p.\ 496)}$ Due to these apparent contradictions in research findings, drawing conclusions can sometimes be frustrating. Allen (1973) points out some factors that contribute to this frustration.

> "...a look back over the past 50 years of research is both encouraging and discouraging. We can see no neatly organized body of research findings that can be used to guide our practice. For the most part, past research has been haphazard, poorly integrated, and lacking any theoretical structure. We see little evidence that what we have found out is being applied to instruction or that we are even asking the right questions."$_{(p.\ 49)}$

Allen (1973) seems to suggest a direction for future research when he says: "The major problem facing the researcher is the determination of the specific conditions under which different media should be employed, how the media should be designed, and with what kinds of learners."$_{(p.48)}$

PURPOSE OF THE STUDY

This study was an investigation to determine the instructional media competencies that inservice teachers of secondary education teaching disciplines recommend for pre-service teachers in their discipline. The primary purpose of this study was to identify the instructional media competencies common to all teaching disciplines. In addition, the media competencies unique to each discipline were identified. Consideration was also given to the perceived value of instructional media use in the classroom, length of tenure as a teacher and the teaching location, namely Hawaii, Oregon and Utah. Recommendations were studied relative to the instructional approach in relation to teaching discipline.

DESIGN AND PROCEDURES

Hypotheses

The results of this study determine the retention or rejection of the following null hypotheses:

> H_0 1. There is no significant difference in the recommendation of instructional media competencies among teachers in the secondary education teaching disciplines.
>
> H_0 2. There is no significant difference in the perceived value of instructional media use in the classroom among teachers in secondary education teaching disciplines.
>
> H_0 3. There is no significant difference in the recommended instructional approach among teachers in secondary education teaching disciplines.

Research Questions

The study gave additional consideration to the following research questions each related to the instructional media competency recommendations and teaching disciplines.

1. Is there a difference in instructional media competency recommendations by teachers in secondary education teaching disciplines based on the state in which they are teaching?

2. Is there any difference in the recommendations of instructional media competencies among all teachers in Hawaii, Oregon or Utah?

3. Is there a difference in the perceived value of instructional media use in the classroom among teachers in secondary education teaching disciplines based on the state in which they are teaching?

4. Is there any difference in instructional media competency recommendations based on perceived value of media use in the classroom?

5. Is there any difference in instructional media competency recommendations by teachers in secondary

education teaching disciplines based on perceived value of media use in the classroom?

6. Is there any difference in instructional media competency recommendations by teachers in secondary education teaching disciplines based on years of teaching experience?

7. Is there any difference in the factors for media non-use among teachers in secondary education teaching disciplines?

This paper does not summarize the entire study. Only the findings for hypotheses $H_0 1$, $H_0 2$ and research questions 1-5 above are presented here. These specifically relate to the recommendations of instructional media competencies by inservice teachers from selected secondary education disciplines and their perceived value of media use in the classroom.

Preparation of the Research Instrument

The instrument was a mail administered questionnaire. It consisted of instructional media competencies combined with a six point continuous rating scale ranging from not recommended to recommended. This allowed the respondent to judgmentally recommend the inclusion of each competency in a pre-service teacher education program.

The development of the instrument was accomplished in three stages:

1. Related literature; (Stracke (1932), deBernardis and Brown (1946), Jensen (1986), Meierhenry (1966), Okoboji (1959) and Streeter (1969); were studied to identify lists of media competencies commonly accepted in the field. Current course syllabi from selected universities and colleges offering introductory instructional media courses and current instructional media text books were also surveyed to refine and finalize the list of competencies. (See Table 1)

2. A jury panel of experts was selected that consisted of instructional media specialists and instructors as well as research specialists with expertise in questionnaire

development. Using a modified Delphi procedure, the panel members were asked to respond to the list of competencies on the questionnaire as well as its format and design.

3. The final questionnaire (see Appendix A) was reviewed by a research consultant for final recommendations. The questionnaire was then submitted to the panel for final acceptance or rejection. No panel members responded with further suggestions.

The Statistical Design

The design of the study included the following:

1. The population consisted of in-service teachers of secondary education teaching disciplines from public schools in the states of Hawaii, Oregon and Utah. A random numbers list was computer generated. Using current state school directories twenty-five (25) schools were randomly selected from each state. Each list of schools was reviewed for a match of size and location, ie:, rural, urban and metropolitan. A mailing list was computer generated for each of thirteen disciplines for each school. A total of three-hundred and twenty-five (325) mailings for each state or a total of nine-hundred and seventy-five (975) was prepared.

Using the procedures outlined by Dillman (1978) a questionnaire was mailed to teachers of the secondary education teaching disciplines. A cover letter was included explaining the purpose of the study and the importance of each response to the success of the study. Each questionnaire was numbered for follow-up purposes. A business reply envelope was included for return of the questionnaire. All the questionnaires were mailed on the same day.

Following Dillman's (1978) procedure a post-card follow-up reminder was prepared and mailed to all teachers in the study exactly one week after the first mailing.

As the questionnaires were returned they were checked off against the original mailing list. The intent was to send a second mailer with questionnaire to those not responding within a three week period. This was not accomplished due to the lack of time before the end of public school in the three states of the study.

Originally there were thirteen (13) secondary education teaching disciplines identified. As the questionnaires were returned and checked off it was noticed that there were very few being returned from "Computer Science" teachers. Most of the ones that were identified as "Computer Science" teachers had been addressed to "Mathematics" teachers. It was also observed that many being returned from "Mathematics" teachers had actually been addressed to "Computer Science" teachers. It was decided that for purposes of this study it would be appropriate to combine the teaching discipline category "Computer Science" with "Mathematics". The combined category was entitled "Mathematics/ Computer Science." This resulted in twelve secondary education teaching disciplines for the study.

A period of one week was allowed to lapse after receiving what seemed to be the last response before the data were compiled and submitted for computer analysis. At the time of data compilation four-hundred and sixteen (416) or 43% of the total questionnaires had been returned. All questionnaires were usable and were included in the data pool. Of the four-hundred and sixteen (416) returns one-hundred and fifty-three (153) were from Hawaii. This represents a 47% return rate. There were one-hundred and twenty-six (126) from Oregon for a 39% return. Utah had one-hundred and thirty-seven (137) or a 42% return. The numbers returned were good considering only one follow-up reminder was sent. There were four additional questionnaires returned after the data were compiled and submitted. They were left out of the study. (See Table 2 for response frequencies by teaching discipline and location.)

2. The respondents were asked to make recommendations for instructional media competencies, perceived value of instructional media use in the classroom and recommendations of an instructional approach. The responses were recorded using a six point continuous scale, with values ranging from a low of 0 to a high of 5.0.

The data from the questionnaires were transferred to computer by the writer. The raw data were stored in disk form and then transferred to the university main frame Prime Computer for analysis. The analysis files were created and computed using the Statistical Package for Social Sciences-X (SPSSX) release 3.0.

3. The one-way analysis of variance was selected as the statistical analysis to test the three null hypotheses because they require the contrasting of two (2) or more means. The Duncan Multiple Range Test was utilized to determine which of the means of the teaching disciplines differed significantly for each of the instructional media competencies.

In addition to the one-way analysis of variance as described above, the t-Test was also used to develop information regarding one of the research questions (number 6) described above.

A total of six-hundred and eighty (680) one-way ANOVA's were computed. A total of six-hundred and seventy-two t-test's were completed. A series of cross tabulation tables and mean's tables were also completed.

4. The F Test was used to test the significance of the analysis. The alpha level for significance was set at p=.05 for all one-way ANOVA's. For informational purposes the t-Test results were compiled for p=.10 as well as p=.05.

5. Utilization of the data and information compiled requires more than quantitative analysis. The objective of the study is to develop a series of competency lists that are, first, common to all secondary education teaching disciplines and that are, second, unique to each teaching discipline or groups of disciplines. This requires reviewing the data and making qualitative judgments about the importance of each competency by teaching discipline.

DATA ANALYSIS AND FINDINGS

Responses to the questionnaire elicited from teachers in secondary education teaching disciplines within selected states were compiled for computer analysis using the SPSSX release 3.0 statistical package. The computer analysis produced the following findings for each of the hypotheses and research questions listed below.

Hypotheses

H_0 1. There is no significant difference in the recommendation of instructional media competencies among teachers in the secondary education teaching disciplines.

A one-way analysis of variance was computed for each of fifty-six (56) instructional media competencies plus four (4) "other" categories. (The four "other" categories produced no responses on the returns so they were disregarded in the analysis.) Of the fifty-six ANOVA's completed, thirty-six (36) or 64% indicated a significant difference in recommendations of instructional media competencies between teachers in the secondary education teaching disciplines at the .05 level of confidence or above. For these competencies null hypothesis H_0 1 is rejected. Twenty (20) or 36% indicated no significant difference. For these competencies null hypothesis H_0 1 is retained.

(Tables are available upon request.)

H_0 2. There is no significant difference in the perceived value of instructional media use in the classroom among teachers in secondary education teaching disciplines.

A one-way analysis of variance was computed along with the Duncan Multiple Range Test. A significant difference was indicated among how the teaching disciplines perceive the value of instructional media use in the classroom. Null hypothesis H_0 2 is rejected at the .0002 level of confidence. The results of the Duncan Multiple Range Test indicate that Industrial Arts teachers have the highest perceived value of instructional media use in the classroom with a mean of 4.17 while Music teachers with a mean of 2.90 have the lowest perceived value of instructional media use in the classroom. Eleven of the teaching disciplines (Industrial Arts, Home Economics, Health, Social Sciences, Sciences, Foreign Languages, Language Arts, Business, Art, Physical Education and Mathematics/Computer Science) were significantly different from Music. Three of the teaching disciplines (Industrial Arts, Home Economics and Health) were significantly different than Mathematics/Computer Science and Music. Table 3 displays the relative ranking of teaching disciplines by perceived value of instructional media use in the classroom.

(Tables are available upon request.)

Research Questions

While not stated as formal hypothesis the following research questions have been included in order to help clarify the information developed by this research. Each of the questions presented below expands upon what has been discussed relative to the impact of secondary education teaching disciplines upon teachers recommendations for specific instructional media competencies and their perceived value of instructional media use in the classroom.

1. **Is there a difference in instructional media competency recommendations by teachers in secondary education teaching disciplines based on the state in which they are teaching?**

A one-way analysis of variance was computed for each of the fifty-six instructional media competencies controlling for the states of Hawaii, Oregon and Utah. A total of one-hundred and sixty-eight (168) ANOVA's were completed.

For the state of Hawaii, eleven (11) or 20% of the recommendations for instructional media competencies tested significantly different among secondary education teaching disciplines at the .05 level of confidence or higher. Forty-five (45) or 80% of the instructional media competencies showed no significant difference among teaching disciplines.

For the state of Oregon, twenty-two (22) or 39% of the recommendations for instructional media competencies tested significantly different among secondary education teaching disciplines at the .05 level of confidence or higher. Thirty-four (34) or 61% of the instructional media competencies showed no significant difference among teaching disciplines.

For the state of Utah, eleven (11) or 20% of the recommendations for instructional media competencies tested significantly different among secondary education teaching disciplines at the .05 level of confidence or higher. Forty-five (45) or 80% of the instructional media competencies showed no significant difference among teaching disciplines.

A Duncan Multiple Range Test was computed for each instructional media competency found to have significant difference in order to determine which teaching disciplines were different.

(Tables are available upon request.)

2. Is there any difference in instructional media competency recommendations among all teachers in Hawaii, Oregon or Utah?

A one-way analysis of variance was computed for each of the fifty-six instructional media competencies using teaching location as a variable. Of the fifty-six ANOVA's completed, nineteen (19) or 34% indicated a significant difference in recommendations for instructional media competencies among all secondary education teachers in the states of Hawaii, Oregon and Utah at the .05 level of confidence or above. Thirty-seven (37) or 66% indicated no significant difference. A Duncan Multiple Range Test was conducted for each of the competencies indicating significant difference.

(Tables are available upon request.)

3. Is there a difference in the perceived value of instructional media use in the classroom among teachers in secondary education teaching disciplines based on the state in which they are teaching?

A one-way analysis of variance was computed for each teaching location namely Hawaii, Oregon and Utah. For the states of Hawaii and Oregon there were no significant differences in the perceived value of instructional media use in the classroom found among teachers in the secondary education teaching disciplines.

For the state of Utah, a significant difference in the perceived value of instructional media use in the classroom among teachers in the secondary education teaching disciplines was found at the .0008 level of confidence. A Duncan Multiple Range Test was computed to determine which teaching disciplines were significantly different. The result of the Duncan Procedure indicates that Science teachers in the state of Utah with a mean = 4.40 are significantly different than Music teachers with a mean = 2.25, Physical Education teachers with a mean = 3.14, Business teachers with a mean = 3.39 and Math/Computer Science teachers with a mean = 3.44. In addition, all other teachers, ie., Health, Home Economics, Industrial Arts, Art, Language Arts, Foreign Language, Social Science and Math/Computer Science are significantly different than Music teachers.

(Tables are available upon request.)

4. Is there any difference in instructional media competency recommendations based on perceived value of instructional media use in the classroom?

The data relative to perceived value of instructional media use in the classroom was recoded from continuous to categorical. Responses of 0, 1, 2, and 3 were grouped together into category 1=low perceived value of instructional media use in the classroom. Response 4 became category 2=medium perceived value of instructional media use in the classroom. Response 5 became category 3=high perceived value of instructional media use in the classroom. There were one-hundred and fifty-one (151) respondents or 36% in category 1-low perceived value; one-hundred and forty (140) respondents or 34% in category 2-medium perceived value; and one-hundred and twenty-five (125) respondents or 30% in category 3-high perceived value of instructional media use in the classroom.

After recoding, a one-way analysis of variance was computed for each of the fifty-six (56) instructional media competencies. Of the fifty-six ANOVA's completed, forty-one (41) or 73% indicated a significant difference in recommendations of instructional media competencies among teachers having low, medium and high perceived value of instructional media use in the classroom at the .05 level of confidence or above.

(Tables are available upon request.)

5. Is there any difference in instructional media competency recommendations by teachers in secondary education teaching disciplines based on perceived value of instructional media use in the classroom?

A one-way analysis of variance was computed for each of the fifty-six instructional media competencies controlling for each of three categories (low, medium and high) of perceived value of instructional media in the classroom. A total of one-hundred and sixty-eight (168) ANOVA's were completed.

Selecting only teachers with a **low** perceived value of instructional media use in the classroom twenty-two (22) or 39% of the recommendations for instructional media competencies tested significantly different among secondary education teaching disciplines at the .05 level of confidence or higher. Thirty-four (34) or 61% of the instructional media competencies showed no significant difference among teaching disciplines.

Selecting only teachers with a **medium** perceived value of instructional media use in the classroom sixteen (16) or 29% of the recommendations for instructional media competencies tested significantly different among secondary education teaching disciplines at the .05 level of confidence or higher. Forty (40) or 71% of the instructional media competencies showed no significant difference among teaching disciplines.

Selecting only teachers with a **high** perceived value of instructional media use in the classroom three (3) or 5% of the recommendations for instructional media competencies tested significantly different among secondary education teaching disciplines at the .05 level of confidence or higher. Fifty-three (53) or 95% of the instructional media competencies showed no significant difference among teaching disciplines.

(Tables are available upon request.)

To assist with qualitative analysis and determination of appropriate lists of instructional media competencies by teaching disciplines, a series of means tables (available upon request) were developed of all fifty-six instructional media competencies by teaching disciplines.

Table 4 presents the breakdown of the recommendation scale by percentiles. This provides some criteria for the selection of instructional media competencies either for the total population of secondary education teaching disciplines or for individual teaching disciplines. A mean of 4.00 or better is at or above the 80th percentile and represents a **very** strong recommendation. A mean between 3.50 and 3.95 or the 70th to 79th percentile represents a strong recommendation for any given instructional media competency. Table 5 presents a summary of the competencies by teaching discipline and the selection of each competency by discipline at or above the 70th and 80th percentiles. The competencies selected for the total population are from those indicating no significant difference from the analysis of variance described above.

CONCLUSIONS AND RECOMMENDATIONS

The analysis of the data collected presents evidence to support several conclusions regarding teaching disciplines, instructional media competencies and perceived value of media use in the classroom. The first hypothesis focused on the significant differences among the teachers of secondary education teaching disciplines and their recommendations of instructional media competencies to be taught to pre-service teacher education students in their disciplines. While the data does not indicate differences for the total set of media competencies there is enough evidence to make a general conclusion.

> Conclusion 1
> The teaching discipline influences recommendations by inservice teachers of secondary education for instructional media competencies to be included in a pre-service teacher education program.

Research question one, ("*Is there a difference in instructional media competency recommendations by teachers in secondary education teaching disciplines based on the state in which they are teaching?*"), and two, ("*Is there any difference in instructional media competency recommendations among all teachers in Hawaii Oregon or Utah?*"), are concerned with the teaching location namely Hawaii, Oregon and Utah and the recommendations of instructional media competencies. The data indicates a significant difference exists among teachers of secondary education teaching disciplines in the states of Hawaii, Oregon and Utah regarding their recommendations of instructional media competencies to be included in a pre-service teacher education program. For Hawaii and Utah there were eleven (11) competencies indicating significant difference, while in Oregon there were twenty-two (22). Careful review of the data indicates no evidence to suggest any similarities among teaching disciplines from the different states. The data presented regarding recommendations of instructional media competencies by all teachers in Hawaii, Oregon and Utah indicates that of the nineteen (19) media competencies indicating a significant difference, teachers from Hawaii have the highest recommendation means for all nineteen (19) with Oregon teachers having the lowest recommendation means for eighteen (18) of the nineteen (19) competencies presented.

The second hypothesis focused on the significant differences among teachers of secondary education teaching disciplines and their perceived value of instructional media use in the classroom. The data indicates a significant difference among teachers of secondary education teaching disciplines regarding their perceived value of instructional media use in the classroom. Table 3 provides a ranking of teaching disciplines from high to low of perceived value of instructional media use in the classroom. The hypothesis was rejected at the .0002 level of confidence which gives strong evidence for a second conclusion from this study.

> Conclusion 2
>
> The teaching discipline influences the perceived value of instructional media use in the classroom of inservice teachers of secondary education.

As was the case for research questions one and two as described above, research question three, ("Is there a difference in the perceived value of instructional media use in the classroom among teachers in secondary education teaching disciplines based on the state in which they are teaching?"), focused on the consideration of teaching location. The findings indicate that there were no differences among teachers in Hawaii or Oregon regarding perceived value of instructional media use in the classroom. However, there is a significant difference in the perceived value of instructional media use in the classroom among teachers of secondary education teaching disciplines in Utah at the .01 level of confidence. Music teachers, with a value mean of 2.25, have the lowest perceived value of instructional media use in the classroom while science teachers, with a value mean of 4.40, have the highest perceived value. No conclusions are being suggested, only a recognition that differences exist among teachers in Utah that were not evidenced in either Hawaii or Oregon.

Additional information was developed relative to the consideration of perceived value of instructional media use in the classroom by research question four; "Is there any difference in instructional media competency recommendations based on perceived value of instructional media use in the classroom." By recoding the perceived value of instructional media data into categorical levels of low, medium and high it was possible to further analyze the teachers recommendations of instructional media competencies to be included in a pre-service teacher education program. The findings indicate that there is significant difference among teachers having low, medium and high perceived value of instructional media use in the classroom regarding recommendations of forty-one (41) of the fifty-six (56) instructional media competencies studied. In general, all recommendations from teachers having a "high" perceived value of instructional media use in the classroom had a higher mean than either of the other two categories. These data provides evidence to support the following conclusion.

> Conclusion 3
> The perceived value of instructional media use in the classroom by secondary education teachers influences their recommendations of instructional media competencies to be included in a pre-service teacher education program.

The data collected and analyzed regarding research question five, ("Is there any difference in instructional media competency recommendations by teachers in secondary education teaching disciplines based on perceived value of instructional media use in the classroom?"), also support conclusion 3 regarding the influence of perceived value of instructional media use in the classroom on media competency recommendations. There were twenty-two (22) media competencies which indicate significant differences among teachers having a **low** perceived value of instructional media use in the classroom. For teachers with a **medium** perceived value of instructional media use there were sixteen (16) media competencies indicating a significant difference. There were only three media competencies indicating significant differences among secondary education teachers having a **high** perceived value. This set of data suggests that the higher the perceived value of instructional media use in the classroom the fewer differences there are among teachers of secondary education teaching disciplines for instructional media competencies to be included in a pre-service teacher education program.

The intent of this study was to determine the instructional media competencies that inservice teachers of secondary education teaching disciplines recommend for pre-service teachers in their discipline. The primary purpose was to identify the instructional media competencies common to all teaching disciplines and in addition, the media competencies unique to each discipline individually. The final conclusion is in response to the original objectives of the study. Table 5 presents a summary of the instructional media competencies that are recommended by all teachers of secondary education teaching disciplines and those unique to specific teaching disciplines. These are presented in support of the following general conclusion about instructional media competencies significant to teachers of secondary education teaching disciplines.

> Conclusion 4
> There are instructional media competencies that are common to all secondary education teaching disciplines as well as instructional media competencies that are unique to each of twelve secondary education teaching disciplines.

Recommendations

The recommendations set forth in this study are based on two assumptions. According to the literature reviewed, instructional media, if properly used can enhance the teaching/learning process by increasing the amount of learning or reducing the amount of time necessary to accomplish the desired outcome. Second, inservice teachers of secondary education teaching disciplines have knowledge and experience that can provide a better understanding of the needs of pre-service teachers as they are preparing to enter the schools, as indicated by research reviewed and the findings of this study. Given these assumptions, the following recommendations are derived from the results of this study.

> Recommendation 1
> Instructors of secondary education teaching discipline methods courses and instructors of instructional media in institutions of higher education offering teacher education programs should jointly design and develop learning activities that will provide pre-service teacher education students in specific teaching disciplines the instructional media competencies identified as necessary for their discipline.

The recommendation described above could be accomplished by carefully selecting those instructional media competencies that are best developed in a formal instructional media course and those that could best be presented in the methods courses. Each should reinforce and support the other. It is important to recognize that one of the significant components of these courses and activities must be effective and appropriate modeling of these skills and competencies by the instructors involved. Learning about something is not the same as having a continuous example of its application in a realistic setting that represents the environment in which pre-service teacher education students will be working.

Recommendation 2

Specific learning activities should be developed that will enhance the pre-service teacher education students perception of the value of the use of instructional media in the classroom.

This recommendation could be accomplished by instructional media instructors and methods instructors providing their students opportunities to be directly involved in educational innovation projects. These could focus on the application of computer or video technology to the teaching/learning process or in the design and delivery of instruction via telecommunication technology. The benefits of this type activity would be two fold. First, the students would have opportunity to see technology being applied to the teaching/learning process in a "real" setting. Second, by being involved on a participatory/contributive basis, the students will develop a better understanding of the benefits of such programs in terms of direct learner improvement. By being involved they can develop, to a degree, a sense of ownership in the outcomes and ideas of the project. It should be pointed out that such projects do not necessarily have to be high technology based. Providing pre-service teacher education students opportunity to develop and apply new applications of older and more simple technology in the delivery of instructional activities can be just as rewarding.

Recommendation 3

State Teaching Certification Requirements should be written to require evidence that secondary education teachers have both general instructional media competencies as well as specific skills that are significant to their teaching discipline.

The implementation of this recommendation would encourage schools and colleges of education to provide programs that offer courses in instructional media as well as methods courses for each teaching discipline. It would also encourage cross-departmental cooperation in the development and offering of learning activities designed to provide pre-service teacher education students the skills and knowledge necessary to meet the challenges of todays teaching profession.

A Personal Note

Considering the complexity of the teaching/learning process, it would seem that serious energy and thought should be expended on behalf of reform of pre-service teacher education programs. Teachers today are facing the challenge of preparing their students for a world that none of them can even begin to envision. This requires a level of preparation and skill that has not been demanded in the past. In order for teacher education programs to meet their responsibility to prepare future teachers, it is necessary to develop a greater sense of and commitment to, cooperative efforts among departments and faculty. Effort needs to be made that will breakdown the departmentalization and compartmentalizing of the various components within the university that make up a typical teacher education program. Pre-service teacher education students need to experience an integrated, cooperative program where each contributor is seen as professional and integral to the total educational system. Subject matter specialists, methods instructors, classroom management specialists, media specialists and the other applications specialists must work together to provide the student with an understanding of how each adds to the success of system.

A final observation from this research would be that inservice teachers place value on the skills and instructional media competencies that they use in their classrooms. They also seem to be saying that one of the ways they developed a sense of value for their use was through example (or non-example) presented by their methods instructors. The methods teacher, working in cooperation with the instructional media/technology information specialist has a unique opportunity to present methods, instructional approaches and media utilization in a way that can not be duplicated elsewhere. When the pre-service teacher of a particular discipline can see methods and materials being used in the context of the subject of interest, they are more likely to attempt to utilize or replicate that in their own classroom when the time comes.

The preparation of tomorrows teachers is a serious challenge. With the application of effective research, technology and an ever increasing understanding of the process of learning the task will be accomplished. Teacher education has never before been presented with such an opportunity to make a life altering contribution to the students of tomorrow. Pre-service teachers today must be given the tools and knowledges necessary to provide learning experiences for the students of tomorrow. Those students will be required to do more than rote recitation; they will need to function in a technological/information based society that demands high level thinking skills. The traditional textbook and lecture bound teacher preparation program does not provide the level of skills and knowledge required. A change is required for the teacher education program of tomorrow. Cooperation and integration among all faculty within the teacher education program will lead to a far better prepared teacher of tomorrow.

COMPLETE BIBLIOGRAPHY

1. AECT. 1982. A Survey of Media Instruction in Undergraduate Teacher Education. Instructional Innovator. Sept. 27(6). 32-34.

2. AECT. 1977. The Definition of Educational Technology. Association for Educational Communications and Technology. Washington D.C.

3. Allen, William H. 1973. What Do Fifty Years of Media Research Tell Us? Audiovisual Instruction. March. 18(3). 48-49.

4. Beckett, Alvin C. 1968. Instructional Media and Educational Preparation for Business and Industry. In the Instructional Process and Media Innovation. Rand McNally & Comp., Chicago.

5. Bellamy, R., Whitaker, H. & White, R. 1978. Teacher Attitudes Toward Non-Print Media. ERIC. Dec. ED174197. 1-33.

6. Blythe, Hal & Sweet, Charlie. 1983. Using Media to Teach English. Instructional Innovator. Sept. 22-24.

7. Caffarella, Edward P. and Sachs, Steven G. 1988. Doctoral Research in Instructional Design and Technology: A directory of Dissertations 1977-1986. 310. Association for Educational Communications and Technology: Washington D.C.

8. Carter, Alex & Schmidt, Kenneth C. 1985. An Assessment of the Production and Utilization of Instructional Media by Student Teachers. Educational Technology. Nov. 25(11). 30-32.

9. Carter, Alex & Wedman, John. 1984. A Survey of Classroom Media Use. Instructional Innovator. Sept/Oct. 29(6). 36-8.

10. Clark, Richard E. and Salomon, Gavriel. 1985. Media in Teaching. In the Handbook of Research on Teaching, 3rd Edition. MacMillan Publishing Company: New York.

11. Cochran, Lee W. 1973. In the Beginning...it was DVI. Audiovisual Instruction. March. 18(3). 42-43.

12. Courtney, Wayne E. 1984. Analysis. Oregon State University: Corvallis, Oregon.

13. Dale, Edgar. 1953. What Does it Mean to Communicate. AV Communication Review. Winter. 1(1). 3-5.

14. de Kieffer, Robert E. 1948. The Status of Teacher Training in Audiovisual Education in the Forty-Eight States. Doctoral Dissertion. State University of Iowa.

15. de Kieffer, Robert E. 1959. AV activities of Colleges and Universities in Teacher Education. Audio-Visual Communication Review. Feb. 7(2). 122-137.

16. de Kieffer, Robert E., De Kieffer, Melissa H. 1970. Media Milestones in Teacher Training. ERIC. ED035318. 1-80.

17. de Kieffer, Robert E., de Kieffer, Melissa H. 1977. Media Milestones in Teacher Training Revisited. Research Report (Private Publication). Information Futures, Pulman, Washington.

18. deBernardis, Amo and Brown, James W. 1946. A Study of Teacher Skills and Knowledges Necessary for the Use of Audio-Visual Aids. Elementary School Journal. June. 46(10). 550-556.

19. Dillman, Don A. 1978. Mail and Telephone Surveys. John Wiley and Sons., New York.

20. Dyrenfurth, Michael J., Miller, Milton F. 1984. Media Use in Vocational/Technical Education. Media & Methods. Oct. 21(2). 10-13.

21. Elliott, Peggy G., Ingersoll, Gary M., Smith, Carl B. 1984. Trends and Attitudes in the Use of Educational Media and Materials. Educational Technology. April. 24(4). 19-24.

22. Ely, Donald P. 1984/85. A Pathfinder to the Literature of Educational Technology. International Yearbook of Educational and Instructional Technology. 63-66. Nichols Publishing Comp., New York.

23. Ely, Donald P. 1973. Defining the Field of Educational Technology. Audiovisual Instruction. March, 18(3). 52-53.

24. Finn, James D. 1967. In The Teacher and Technology. 16mm film, sound, bw. Columbus, Ohio: Motion Picture Division; Ohio State University.

25. Fulton, W. R. and White, Frederick A. 1959. What Constitutes Teacher Competence in Audio-Visual Communication? Phi Delta Kappan. January. 40. 158-160.

26. Fulton, W.R. 1960. Audio-Visual Competence and Teacher Preparation. Journal of Teacher Education. December. 11(4). 492-496.
27. Goodlad, John. 1983. A Study of Schooling: Some Findings and Hypotheses. Phi Delta Kappan. 7. 465-470.

28. Hansen, Viggo. 1983. Using Media to Teach Math. Instructional Innovator. Sept. 25-6.

29. Harrod, Norma M. 1977. Use Media? Me? I'd like to, but... Audiovisual Instruction. Oct. 22(8). 53.

30. Heinich, Robert; Molenda, Michael; and Russell, James D. 1989. Instructional Media and the New Technologies of Instruction. 3rd Ed. NacMillan Publishing Comp., New York.

31. Hoban, Charles F. 1965. From Theory to Policy Decisions. AV Communications Review. Summer. 13(2). 121-139.

32. Jamison, Dean; Suppes, Patrick; Wells, Stuart. 1974. The Effectiveness of Alternative Instructional Media: A Survey. Review of Educational Research. Winter. 44(1). 1-68.

33. Jensen, Edward A. 1986. Course Content and Textbook Selection. Conference presentation: AECT. 1-7. Association For Educational Educational Communications and Technology: Washington, D.C.

34. Jones, Gay N. 1982. The Relationship of Media Training and Media Use by Student Teachers and First Year Teachers. Doctoral Dissertation. Dec. University of Toledo.

35. Kemp, Jerrold E. 1989. Planning and Producing Audiovisual Materials, 6th edition. Thomas Y. Crowell: New York.

36. Knirk, Federick G. and Gustafson, Kent L. 1986. Instructional Technology: A Systematic Approach to Education. Holt, Rinehart and Winston: New York.

37. Laird, Nicola R. 1978. Which Media Do Teachers Use Most? Audiovisual Instruction. Sept. 23(6). 23-25.

38. Lare, Gary A. 1974. Media Education in Elementary Teacher Programs at Selected Teacher-Education Institutions. Doctoral Dissertation. Aug. Kent State University, Graduate School.

39. Levie, W. Howard & Dickie, Kenneth E. 1973. The Analysis and Application of Media. In the Second Handbook of Research on Teaching. 858-882. Chicago: Rand McNally College Publishing Co.

40. Lumsdaine, A. A. 1963. Instruments and Media in Instruction. In the Handbook of Research on Teaching. 583-682. Chicago: Rand McNally & Co.

41. McCutcheon, John Walter. 1984. Factors Influencing the Content of Introductory Educational Media Courses. Doctoral Dissertation. Aug. Indiana University.

42. Meierhenry, W. C. 1966. Media Competencies for Teachers, a Project to Identify Competencies needed by Teachers in the use of the newer media and various approaches to achieving them. ERIC. March, ED012713. 1-237.

43. Meierhenry, Wesley C. 1967. Teacher Competencies Project. Audiovisual Instruction. Dec. 12(10). 1030-31.

44. Moldstad, John A. 1974. Selective Review of Research Studies Showing Media Effectiveness: A Primer for Media Directors. A V Communication Review. Winter. 22(4). 387-407.

45. National Association of State Directors of Teacher Education and Certification. 1988. Manual on Certification and Preparation of Educational Personnel in the United States. National Association of State Directors of Teacher Education and Certification: Sacramento, CA.

46. Okoboji. 1959. The Okoboji Report. Audio-Visual Instruction. January. 4. 4-6.

47. Osguthorpe, Russell T. and Zhou, Lian. 1989. Instructional Science: What is It and Where Did It Come From?. Educational Technology. June. 29(6). 7-17.

48. Ott, Lyman. 1977. An Introduction to Statistical Methods and Data Analysis. Duxbury Press: Massachusetts.

49. Proctor, Leonard F. 1983. Student Teacher Utilization of Instructional Media. Doctoral Dissertation. June. Indiana University.

50. Rasmussen, Warren I. 1968. Instructional Porcess and Media Integration in the Creative Arts. In the Instructional Process and Media Innovation. Rand McNally & Comp., Chicago.

51. Rome, S.F. 1973. The Relationship Between suggested Media Competencies and Those Recommended by Audiovisual Instructors, Methods Instructors, and High School Principals. Doctoral Dissertation. Indiana University.

52. Saettler, Paul. 1968. A History of Instructional Technology. McGraw-Hill Book Comp., New York.

53. Schramm, Wilbur. 1977. Big Media, Little Media: Tools and Technologies for Instruction. 12-58. Sage Publications.

54. Seidman, Steven A. 1986. A Survey of Schoolteacher's Utilization of Media. Educational Technology. Oct, 26(10). 19-23.

55. Shure, Alexander. 1968. Science Education and Instructional Systems. In the Instructional Process and Media Innovation. Rand McNally & Comp., Chicago.

56. Sibalwa, David M. 1982. A Descriptive Study to Determine the Effect that Training, Experience and Availability Have on Use of Instructional Media in the Classroom by Preservice Teachers. Doctoral Dissertation. Michigan State University.

57. Sigda, Robert B. 1983. Using Media to Teach Science. Instructional Innovator. Sept. 27-29.

58. Silber, Kenneth. 1970. What Field Are We In Anyhow? Audiovisual Instruction. May. 15(5). 21-24.

59. Smith, William R. . 1969. A Study of Audiovisual Utilization in Elementary Social Studies Methods Course in the Pennsylvania State Colleges. Doctoral Dissertation. Pennsylvania State University.

60. Starnes, W. Gayle. 1937-38. Present Status of Teacher Training in the Use of Visual Aids. bibliog. Ed. Screen. Dec. & Jan. 16&17. 315-16+; 12-14+.

61. Stracke, George A. 1932. What is being taught in Courses in Visual Instruction? Ed. Screen. Sept. 11. 204.

62. Streeter, C. Edward. 1969. Teacher Competency and Classroom Use of Educational Media. Audiovisual Instruction. Jan. 14(1). 60-62.

63. Taylor, J.W. 1942. Preparation of Teachers in Training and Teachers in Service for the More Effective Use of Visual Aids. Masters Thesis. University of Nebraska, Graduate College.

64. Thomas, James L. (Ed.). 1982. Nonprint in the Secondary Curriculum. Libraries Unlimited: Colorado.

65. Thomas, James. E. (Ed.). 1982. Nonprint in the Elementary Curriculum. Libraries Unlimited: Colorado.

66. Trow, William Clark. 1968. Social Studies and Humanities. In the Instructional Process and Media Innovation. Rand McNally & Comp., Chicago.

67. Wallington, Clinton James. 1974. A Theoretical Construct for the Application of the Concept of New Careers to Instructional Technology. Doctoral Dissertation. University of Southern California.

68. Wilcock, Arlen D. 1986. A Set of Self-Instructional Manuals for Audiovisual Equipment Operation. Masters Thesis. Brigham Young University: Provo, Utah.

69. Wilkinson, Gene L. 1980. Media in Instruction: 60 Years of Research. Association for Educational Communications and Technology.

TABLES

Table 1: Fifty-six Instructional Media Competencies

I. Principles of Communication, Selection, Evaluation and Research

1. Communication Theory
2. Design and Layout of Visual Materials
3. Instructional Design Theory and Practice
4. Media Selection and Evaluation Criteria
5. Impact of Technology on Education
6. Implications of Instructional Media Research
7. Future Trends of Media and Technology in Education
8. Copyright Laws and Education

II. How to PRODUCE Instructional Media Materials

9. Lettering for Instructional Materials
10. Mounting Visuals
11. Laminating Visuals
12. Machine Produced Overhead Transparencies
13. Handmade Overhead Transparencies
14. Display Boards (Bulletin Boards, Displays, etc.)
15. Duplicating Inst. Materials (Dittos, Xerox, etc.)
16. Illustration and Enlargement Techniques
17. Manipulatives (Mathematic materials, etc.)
18. Audio Recording
19. Video Recording (off-air recording)
20. Video Programming (Producing own programs)
21. Still photography
22. Slide/tape programs
23. Computer Assisted Instruction
24. Computer Programming
25. Computer Graphics
26. Games, simulations and media kits

III. How to UTILIZE Instructional Media Materials

27. Non-projected visuals
28. Overhead Transparencies
29. Display Boards (Bulletin Boards, etc.)
30. Flip Charts
31. Chalkboards
32. Duplicated Materials (Dittos, Xerox, etc.)
33. Manipulatives (Mathematic materials, etc.)
34. Audio Recordings
35. Instructional Films and Videos (tape & disc)
36. Broadcast Television
37. Slides
38. Filmstrips
39. Computer Assisted Instruction
40. Computer Interactive Video Programs
41. Games and Simulations
42. Free and Inexpensive Materials
43. Field Trips and Community Resources

IV. How to OPERATE Instructional Media Equipment

44. Overhead Projectors
45. Spirit Duplicators (Ditto)
46. Opaque Projectors
47. Cassette Tape Recorders
48. Record Players
49. Video Tape Recorders
50. Video Camcorder Systems
51. Video Editing Systems
52. 16mm Motion Picture Projectors
53. 2X2 Slide Projectors
54. Filmstrip Projectors
55. Computer Interactive Video Systems
56. Microcomputer Overhead Projector LCD Systems

Table 2: Response Frequencies

	HAWAII	OREGON	UTAH	TOTAL
Art	9	8	12	29
Business	11	9	13	33
Foreign Language	17	8	14	39
Health	15	11	12	38
Home Economics	9	17	15	41
Industrial Arts	9	7	8	24
Language Arts	15	7	14	36
Math/Computer Science	26	16	16	58
Music	9	11	8	28
Physical Education	12	11	7	30
Science	12	16	10	38
Social Science	9	5	8	22
Total	153	126	137	416

Table 3 Relative Ranking of Teaching Disciplines by Perceived Value of Media Use in the Classroom

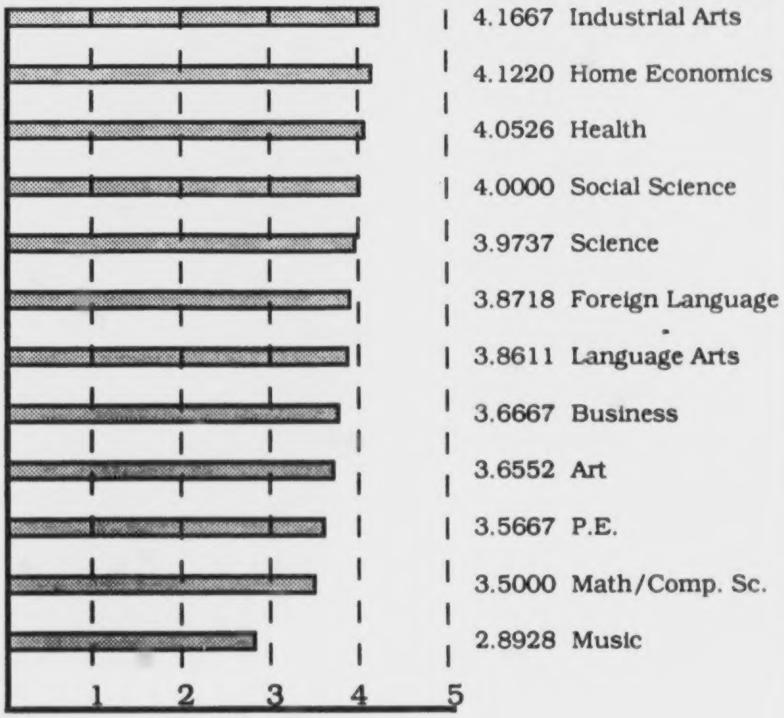
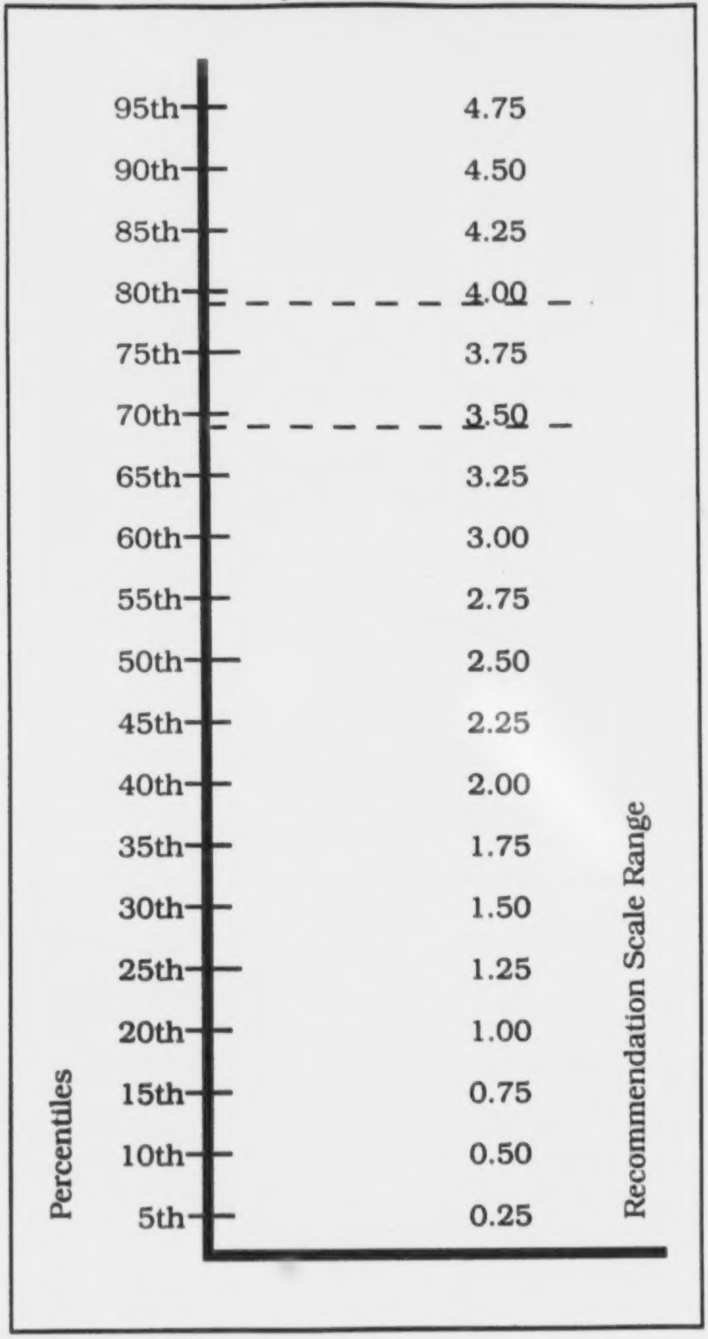


Table 4 Breakdown of Recommendation Scale by Percentile



Percentiles	Recommendation Scale Range
95th	4.75
90th	4.50
85th	4.25
80th	4.00
75th	3.75
70th	3.50
65th	3.25
60th	3.00
55th	2.75
50th	2.50
45th	2.25
40th	2.00
35th	1.75
30th	1.50
25th	1.25
20th	1.00
15th	0.75
10th	0.50
5th	0.25

Table 5 Summary: Selection of Instructional Media Competencies

** = At or above 80th percentile. * = Between 70th and 79th percentile.	Total Population	Art	Business	Foreign Language	Health	Home Economics	Industrial Arts	Language Arts	Math/ Computer Science	Music	Physical Education	Science	Social Science
Foundation and Theory Competencies:													
1. Communication Theory		*	*			*							
2. Design and Layout of Visual Materials	*	**		*	*	*	**	*		*			
3. Instructional Design Theory and Practice		*					*						*
4. Media Selection and Evaluation Criteria	*	*	*			*		*				*	*
5. Impact of Technology on Education		**	**	*			**		*		*	*	
6. Implications of Inst. Media Research													
7. Future Trends of Media and Tech. in Educ	*	*	*	*	*	*	*	*	*		*	*	
8. Copyright Laws and Education	*	*	*	*	*	*	*	*	*	**	*		
Production Competencies:													
9. Lettering for Instructional Materials		*				*		*			*		
10. Mounting Visuals		*				*		*			*		
11. Laminating Visuals		*		*	*	*		*			*		
12. Machine Prod. Transparencies	*	*	**	*	*	*	*	*	*		*	*	*
13. Handmade Transparencies	*		*	*	*	*	*	*	*		*	*	*
14. Display Boards (B.B., etc.)		*	*	*	*	**		*	*	*	**		*
15. Duplicating Inst. Materials (Dittos, Xerox, etc.)	*	*	*	*	**	*	*	*	*	*	**	*	**
16. Illustration and Enlargement Techniques		*	*	*	*	**	*	*			*	*	*
17. Manipulatives (Mathematics materials, etc.)									**			*	
18. Audio Recording				*				*		**			
19. Video Recording (off-air recording)				*	*	*	*	*		**	**	*	*
20. Video Programming (Producing own programs)				**		*	*	*		*	**		*

Table 5 Summary: Selection of Instructional Media Competencies (cont.)

** = At or above 80th percentile. * = Between 70th and 79th percentile.	Total Population	Art	Business	Foreign Language	Health	Home Economics	Industrial Arts	Language Arts	Math/ Computer Science	Music	Physical Education	Science	Social Science
Production Competencies (Cont.):													
21. Still photography		*											
22. Slide/tape programs		*											
23. Computer Assisted Instruction	**	**	**	**	**	**	**	**	**	**	**	**	**
24. Computer Programming	*	*		*	*	*			*	*	*	*	
25. Computer Graphics		**	**	*	*	*	**	*	**	*	**	**	
26. Games, simulations and media kits				**	*	**					*		*
Utilization Competencies:													
27. Non-projected visuals				*		*						*	
28. Overhead Transparencies		*	**	**	*	*		**	**			*	*
29. Display Boards (Bulletin Boards, etc.)		*	**	*	*	*		*			*		
30. Flip Charts													
31. Chalkboards	*		*			*	*		*	*			
32. Duplicated Materials (Dittos, Xerox, etc.)	*		**	*	*	**	*	*	*	*	*	*	*
33. Manipulatives (Mathematics materials, etc.)									**				
34. Audio Recordings				*				*		**			
35. Instructional Films and Videos (tape & disc)		*	*	**	**	**	*	**		**	**	**	*
36. Broadcast Television				*				*			*	*	*
37. Slides		*											
38. Filmstrips		*				*							
39. Computer Assisted Instruction	**	*	**	**	**	**	**	**	**	*	*	**	**
40. Computer Interactive Video Programs	*	**	**	**	*	**	*	*	*		*	**	*

Table 5 Summary: Selection of Instructional Media Competencies (cont.)

** = At or above 80th percentile. * = Between 70th and 79th percentile. *** = Selected because all disciplines recommended inclusion.	Total Population	Art	Business	Foreign Language	Health	Home Economics	Industrial Arts	Language Arts	Math/ Computer Science	Music	Physical Education	Science	Social Science
Utilization Competencies (Cont.):													
41. Games and Simulations			*	**	*	**			*		*	*	*
42. Free and Inexpensive Materials	***	**	**	**	**	**	**	*	*	**	**	*	*
43. Field Trips and Community Resources	***	**	**	**	*	**	*	*	*	**	**	*	*
Operation Competencies:													
44. Overhead Projectors	*	*	*	*	*	**		*	**		*	*	**
45. Spirit Duplicators (Ditto)					*	*			*		*		**
46. Opaque Projectors		*				*							*
47. Cassette Tape Recorders		*				*				**	*		**
48. Record Players										*			*
49. Video Tape Recorders	***	**	**	**	**	**	**	**	*	**	**	**	**
50. Video Camcorder Systems	***	*	**	**	**	*	**	**	*	**	**	**	**
51. Video Editing Systems		*	*	*	*	*	**	*		*	**	*	**
52. 16mm Motion Picture Projectors					*	*					*		*
53. 2X2 Slide Projectors		*											*
54. Filmstrip Projectors		*				*							*
55. Computer Interactive Video Systems	**	**	**	**	*	**	*	*	**	*	**	**	**
56. Microcomputer Overhead Proj. LCD Systems		*	*	*	*	*	**	*	**		*	**	**

APPENDIX

MEDIA COMPETENCY RECOMMENDATION SURVEY

INSTRUCTIONS

The purpose of this survey is to determine instructional media competencies to be included in a pre-service teacher education program as recommended by inservice secondary teachers. Please respond to items as indicated, using the scale described for each category.

Your responses should be based on your experience as a teacher in your current teaching discipline. It would be helpful if you thought in terms of how you would structure an introductory instructional media course for pre-service teachers preparing to teach in your teaching discipline. If you are teaching in more than one discipline please respond based on your university major.

LOCATION : (Check one)

HAWAII ☐
OREGON ☐
UTAH ☐

SCHOOL TYPE: (Check one)

HIGH SCHOOL (9-12) ☐
JR. HIGH SCHOOL (7-8) ☐
COMBINED 7-12 ☐

YEARS TEACHING

NUMBER OF YEARS TEACHING FULL TIME? ☐

SCHOOL ENROLLMENT

APPROXIMATE SCHOOL ENROLLMENT? ☐

MEDIA COURSES

NUMBER OF CREDIT HOURS COMPLETED IN INSTRUCTIONAL MEDIA? ☐ Sem. ☐ Qtr. ☐

TEACHING DISCIPLINE: (Check the **one** that best describes your assignment.)

ART ☐
BUSINESS ☐
COMPUTER SCIENCE ☐
FOREIGN LANGUAGE ☐
HEALTH ☐
HOME ECONOMICS ☐
INDUSTRIAL ARTS ☐
LANGUAGE ARTS ☐
MATHEMATICS ☐
MUSIC ☐
PHYSICAL EDUCATION ☐
SCIENCE ☐
SOCIAL SCIENCE ☐
OTHER_____________ ☐

Are you the building media specialist?
yes ☐ **no** ☐

Value of Media

In General How Would You Rank the **Value** of Instructional Media/Technology in your Classroom?

Not Valued 0 1 2 3 4 5 Highly Valued

The following instructional media competencies are found in most introductory media courses. Using the scale to the right, please indicate your recommendation for their continued inclusion in a pre-service teacher education program based on your experience in your particular teaching discipline.

Not Recommended					Highly Recommended
0	1	2	3	4	5

I. Principles of Communication, Selection, Evaluation and Research

	Not Recommended					Highly Recommended
1. Communication Theory	0	1	2	3	4	5
2. Design and Layout of Visual Materials	0	1	2	3	4	5
3. Instructional Design Theory and Practice	0	1	2	3	4	5
4. Media Selection and Evaluation Criteria	0	1	2	3	4	5
5. Impact of Technology on Education	0	1	2	3	4	5
6. Implications of Instructional Media Research	0	1	2	3	4	5
7. Future Trends of Media and Technology in Education	0	1	2	3	4	5
8. Copyright Laws and Education	0	1	2	3	4	5
9. Other____________________	0	1	2	3	4	5

II. How to PRODUCE Instructional Media Materials

	Not Recommended					Highly Recommended
10. Lettering for Instructional Materials	0	1	2	3	4	5
11. Mounting Visuals	0	1	2	3	4	5
12. Laminating Visuals	0	1	2	3	4	5
13. Machine Produced Overhead Transparencies	0	1	2	3	4	5
14. Handmade Overhead Transparencies	0	1	2	3	4	5
15. Display Boards (Bulletin Boards, Displays, etc.)	0	1	2	3	4	5
16. Duplicating Inst. Materials (Dittos, Xerox, etc.)	0	1	2	3	4	5
17. Illustration and Enlargement Techniques	0	1	2	3	4	5
18. Manipulatives (Mathematic materials, etc.)	0	1	2	3	4	5
19. Audio Recording	0	1	2	3	4	5
20. Video Recording (off-air recording)	0	1	2	3	4	5
21. Video Programming (Producing own programs)	0	1	2	3	4	5
22. Still photography	0	1	2	3	4	5
23. Slide/tape programs	0	1	2	3	4	5
24. Computer Assisted Instruction	0	1	2	3	4	5
25. Computer Programming	0	1	2	3	4	5
26. Computer Graphics	0	1	2	3	4	5
27. Games, simulations and media kits	0	1	2	3	4	5
28. Other____________________	0	1	2	3	4	5

III. How to UTILIZE Instructional Media Materials (apply media in the teaching/learning process)

	Not Recommended					Highly Recommended
29. Non-projected visuals	0	1	2	3	4	5
30. Overhead Transparencies	0	1	2	3	4	5
31. Display Boards (Bulletin Boards, etc.)	0	1	2	3	4	5
32. Flip Charts	0	1	2	3	4	5
33. Chalkboards	0	1	2	3	4	5
34. Duplicated Materials (Dittos, Xerox, etc.)	0	1	2	3	4	5
35. Manipulatives (Mathematic materials, etc.)	0	1	2	3	4	5
36. Audio Recordings	0	1	2	3	4	5
37. Instructional Films and Videos (tape & disc)	0	1	2	3	4	5
38. Broadcast Television	0	1	2	3	4	5
39. Slides	0	1	2	3	4	5
40. Filmstrips	0	1	2	3	4	5
41. Computer Assisted Instruction	0	1	2	3	4	5
42. Computer Interactive Video Programs	0	1	2	3	4	5
43. Games and Simulations	0	1	2	3	4	5
44. Free and Inexpensive Materials	0	1	2	3	4	5
45. Field Trips and Community Resources	0	1	2	3	4	5
46. Other________________________	0	1	2	3	4	5

IV. How to OPERATE Instructional Media Equipment

	Not Recommended					Highly Recommended
47. Overhead Projectors	0	1	2	3	4	5
48. Spirit Duplicators (Ditto)	0	1	2	3	4	5
49. Opaque Projectors	0	1	2	3	4	5
50. Cassette Tape Recorders	0	1	2	3	4	5
51. Record Players	0	1	2	3	4	5
52. Video Tape Recorders	0	1	2	3	4	5
53. Video Camcorder Systems	0	1	2	3	4	5
54. Video Editing Systems	0	1	2	3	4	5
55. 16mm Motion Picture Projectors	0	1	2	3	4	5
56. 2X2 Slide Projectors	0	1	2	3	4	5
57. Filmstrip Projectors	0	1	2	3	4	5
58. Computer Interactive Video Systems	0	1	2	3	4	5
59. Microcomputer Overhead Projector LCD Systems	0	1	2	3	4	5
60. Other____________________	0	1	2	3	4	5

Instructional Approach

Please rank the following approaches for teaching instructional media competencies in the order you would recommend based on your experience in your particular teaching discipline.

Ranking (1st-5th)

1. Formal Courses in Instructional Media. ☐
2. Media Competencies Integrated within the Teaching Methods Courses. ☐
3. Media Competencies Integrated within all Education Courses. ☐
4. Combination of Formal Courses and an Integration of Media Competencies within the Teaching Methods Courses. ☐
5. Other____ ☐

Course Emphasis

The following categories of instructional media competencies constitute the curriculum in an introductory instructional media course. Indicate the percentage of emphasis that you would recommend for each category. (see pages 2 and 3 for reference)

I. Principles of Communication, Selection, Evaluation and Research. (see page 2) ☐ %

II. How to Produce Instructional Media Materials. (see page 2) ☐ %

III. How to Utilize Instructional Media Materials. (see page 3) ☐ %

IV. How to Operate Instructional Media Equipment. (see page 3) ☐ %

100%

Non-Use Factors Check all the factors that most frequently contribute to your descision not to use instructional media in the classroom.

1. Textbook materials are adequate. ☐
2. Do not believe media would help. ☐
3. Media is too time consuming. ☐
4. Arranging to use media is too great a hassle. ☐
5. Media hardware are too difficult to operate. ☐
6. Media materials in the school are outdated. ☐
7. No administrative support for using media. ☐
8. Other____________________________ ☐

Thank you for your help. Please place your completed questionnaire in the self addressed prepaid mailer and return it to the researcher at your earliest convenience. If you would like to review the results of the study please include your name and address.

Title:

Learner-Generated vs. Instructor-Provided Analysis of Semantic Relationships

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Learner-generated vs. Instructor-provided
Analysis of Semantic Relationships

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Learning and Semantic Networks

Our semantic networks represent our knowledge structures which enable learners to combine ideas, infer, extrapolate or otherwise reason from them. Learning consists of building new structures by constructing new nodes and interrelating them with existing nodes and with each other. The more links that can be formed between existing knowledge and new knowledge, the better the information will be comprehended and the easier learning will be. Learning, according to semantic network theory, is the reorganization of the learner's knowledge structure. During the process of learning, the learner's knowledge structure begins to resemble the the knowledge structures of the instructors, and the degree of similarity is a good predictor of classroom examination performance (Diekhoff, 1983; Shavelson, 1974; Thro, 1978). Instruction then may be conceived of as the mapping of subject matter knowledge (usually that possessed by the teacher or expert) onto the learner's knowledge structure.

If we accept the conception that learning is involves the reorganization of the learner's cognitive structure, then instruction involves the assimilation of the expert's knowledge structure by the student. In order to help students reorganize and tune their knowledge structures, we need instructional strategies for depicting and displaying appropriate knowledge structures to students and tools for organizing their knowledge structures. Instructional strategies may illustrate or convey appropriate knowledge structures to students, whereas the tools or learning strategies may help learners to acquire and refine their own knowledge structures (Jonassen, Beissner, & Yacci, in press). This study compares the effectiveness of an instructional strategy which displays appropriate knowledge structures with a learning strategy that engage learners in defining knowledge structures. The former strategy illustrates key concepts and their interrelationships where the latter requires the learners to identify and classify relationships between key concepts, which plae more intelectual responsibulity onto the students for meaning-making.

The learning variable that is being investigated here is structural knowledge. Structural knowledge is the knowledge of how concepts within a domain are interrelated (Diekhoff, 1983). Structural knowledge enables learners to form the connections that they need to describe and use scripts or complex schemas. It is a form of conceptual knowledge that mediates the translation of declarative knowledge into procedural knowledge.

Instructional Strategies vs. Learning Strategies

An instructional strategy is a method or technique for providing instruction to learners. They are implemented through instructional teactics (Jonassen, Grabinger, & Harris, 1991). For instance, an instructional strategy may recommend motivating the learner prior to instruction, which may call for tactics such as arousing learner uncertainty, asking a question or presenting a picture. A strategy aimed at teaching a concrete concept may call for the use of tactics such as matched example-nonexample pairs or deriving the criterion attributes from a set of examples. Instructional strategies provide the overall plan that guides the selection of instructional tactics that facilitate learning. Instructional strategies may be divided into four main classes: contextualizing instruction, providing learner control, organizing and cueing learning, and assessing and evaluating learning. Instructional strategies are instructor-provided interventions that are meant to stimulate learner processing of information.

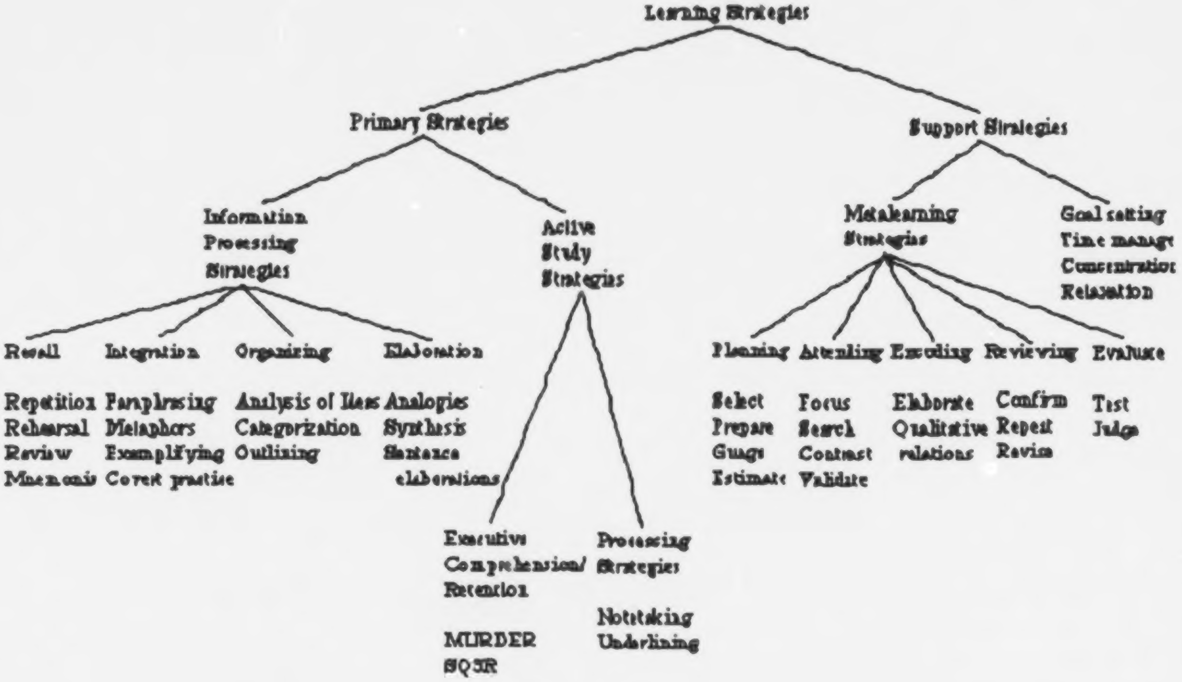
Learning Strategies
Primary Strategies
Support Strategies
Information Processing Strategies
Active Study Strategies
Metalearning Strategies
Goal setting
Time manage
Concentratio
Relaxation
Recall
Integration
Organizing
Elaboration
Repetition
Rehearsal
Review
Mnemonics
Paraphrasing
Metaphors
Exemplifying
Covert practice
Analysis of Ideas
Categorization
Outlining
Analogies
Synthesis
Sentence elaborations
Executive Comprehension/ Retention
MURDER
SQ3R
Processing Strategies
Notetaking
Underlining
Planning
Attending
Encoding
Reviewing
Evaluate
Select
Prepare
Guage
Estimate
Focus
Search
Contrast
Validate
Elaborate
Qualitative relations
Confirm
Repeat
Revise
Test
Judge

Figure 1

Learning strategies are mental operations that the learner may use to acquire, retain and retrieve different kinds of knowledge or performance. Figure 1 presents a taxonomy of learning strategies that may be used by learners to integrate new information into their knowledge structures and restructure and synthesize that knowledge. The fundamental difference between instructional strategies and learning strategies is that the former are largely mathemagenic and the latter are generative (Jonassen, 1985). Mathemagenic instructional strategies control the processing of learners while leading them to learning, so they result in anticipated learning outcomes. They facilitate acquisition of specific content knowledge (intentional learning) but generally do not affect or even impede the acquisition of any other knowledge (incidental learning).

Learning strategies, on the other hand, are generative, that is, they enable learners to take an active, constructive role in generating meaning for information by accessing and applying prior knowledge to new material. Wittrock's (1978) generative hypothesis asserts that meaning for material presented by computer or any other medium is generated by the learner's activating and altering existing knowledge structures in order to interpret what is presented. Cognitive learning strategies are intended to increase the number of links between presented information and existing knowledge. Learning strategies, unlike instructional strategies, are learner-controlled as well as learner-generated. They engage the learners and help them to construct meaningful representations, and their success depends upon the learner taking an active role in controlling their use.

Instructional and Learning Strategies for Facilitating Structural Knowledge

There are a number of instructional strategies for conveying structural knowledge representations and therefore affecting the way that learners encode these structures into memory. There are also a number of learning strategies that learners can use to build their own structural knowledge representations (Jonassen, Beissner, & Yacci, in press). Instructional strategies include explicit graphic, mapping techniques, such as graphical organizers, spider maps, semantic maps, and causal interaction maps, for conveying knowledge structures to students. Teachers and designers may use a number of verbal instructional techniques, such as content structures and elaboration theory, to convey the underlying structures in materials to students. A number of graphical learning strategies, such as networking and pattern noting, may be used by learners to build their own knowledge representations. Among these strategies, one of the most effective is a study strategy called the *Frame Game* that was developed to accompany an educational psychology textbook (Clifford, 1981). The Frame Game is a text processing strategy that identifies the most important concepts in a textbook chapter and then requires the learner to identify the relationships between the concepts by assigning them to predetermined, mapped relationships (see Figure 2). This analysis strategy requires that learners search, contrast, validate, elaborate, confirm, and test information from the chapter. These relationship maps may be used to engage learners in generative processing of textual information or to depict the information. In this study, we compare the provision of structural information to learners as a review of the information with the learner analysis of the relationships between the concepts in the chapter.

The arrangements of boxes in Figure 2 represent different relationships between concepts, such as hierarchical, sequential, and associates relationships. Students have to analyze the concepts and decide which combinations can fit into the structures. Such an activity requires deep level semantic analysis of the main ideas in each book chapter.

Purpose of Study

The primary purpose of this study was to compare the effects of a structural knowledge instructional strategy with the effects use of a structural knowledge learning strategy on the acquisition of structural knowledge. Specifically, we wanted to compare the effects of providing graphical organizers in the form of completed Frames with requiring students to complete Frames as a study strategy prior to examinations.

Method

Subjects

Fifty-six students from two sections of a General Psychology (Psy 101) course at a large community college in metropolitan Denver completed the study. Ten other students failed to complete all of the tests so were dropped from the analysis. There were 27 subjects in the Group 1, and 28 in Group 2.

Instruments

Three subject-matter exams were designed for the experiment. Each exam consisted of 60 questions worth one point each, 37 of which were multiple-choice questions testing recall and comprehension of the text and lecture material. In order to assess structural knowledge acquisition following various treatments, we developed three subscales to measure different aspects of structural knowledge: a) 10 relationship proximity judgements, b) 8 semantic relationships, and c) 5 analogies. All of the structural knowledge test questions were developed to focus on relationships between important concepts contained in the textbook chapters.

The relationship proximity judgments required that students judge the strength of the relationship between two terms and assign a number between 1 and 9 to each of several pairs of concepts to indicate how strong a relationship they thought existed between the concepts in each pair

(Diekhoff, 1983; Schvaneveldt, Durso, Goldsmith, Breen, Cooke, Tucker & DeMaio, 1985; Shavelson, 1972). For example:

_____ 2. endorphins -- amygdala

_____ 3. cerebral cortex -- Broca's area

_____ 4. seratonin -- temporal lobe

The semantic relationships subscale consisted of eight multiple choice questions that required students to understand and recognize the nature of the relationship between two concepts. These relationships were paraphrased from the text book. For example:

_____ 16. sensory registers .... short term memory
a. precedes
b. is defined by
c. is independent of
d. is inferred by

_____ 17. acoustic .... memory
a. results in
b. is independent of
c. is opposite of
d. is an example of

Finally, the analogies subscale required students to complete 5 analogies consisting of four of the concepts from the hypertext. For example:

_____ 22. decay : forgetting :: .... : retrieval

a. mood
b. repression
c. rehearsal
d. primacy

_____ 23. acquisition : extinction :: punishment : ....

a. negative reinforcement
b. positive reinforcement
c. variable reinforcement
d. classical conditioning

These questions were used to assess structural knowledge acquisition. In order to provide standards for assessment, the researchers agreed on the answers to each of these questions. Answers to the multiple choice questions were recorded on the front of Scantron answer sheets; semantic-proximity items were written on the back. Exams covered history and methodology of psychology (chapters 1 & 2), physiology, sensation and perception (chapters 3 & 4), and learning and memory (chapters 6 & 7).

Materials

A list of researcher-generated key concepts and terms was generated for each chapter to be used as student study aids; terms were drawn from the textbook, instructor notes and examinations during the previous semester. Researcher-generated study maps were generated for chapters 3, 4, 6, and 7; mapping allowed students to visualize the relationships among terms — superordinate (hierarchical) and sequential organization, as well as the depiction of the terms in classes, analogies, similarities, cause and effect, and opposites (see Figure 2). Templates of maps were designed for a student-generated-mapping exercise to be assigned prior to Exam 3. These maps were the same as the instructor provided maps in Figure 2 except that most of the locations in the maps were empty, requiring the student to fill in the appropriate concepts.

associative learning
chaining
classical conditioning
cognitive learning
conditioned response
conditioned stimulus
discriminated response
discriminated stimulus
extinction
fixed interval
fixed ratio
generalization
habituation
law of contiguity
law of effect
learning
negative reinforcement
operant conditioning
partial reinforcement schedule
punishment
reinforcement
shaping
unconditioned response
unconditioned stimulus
variable interval
variable ratio

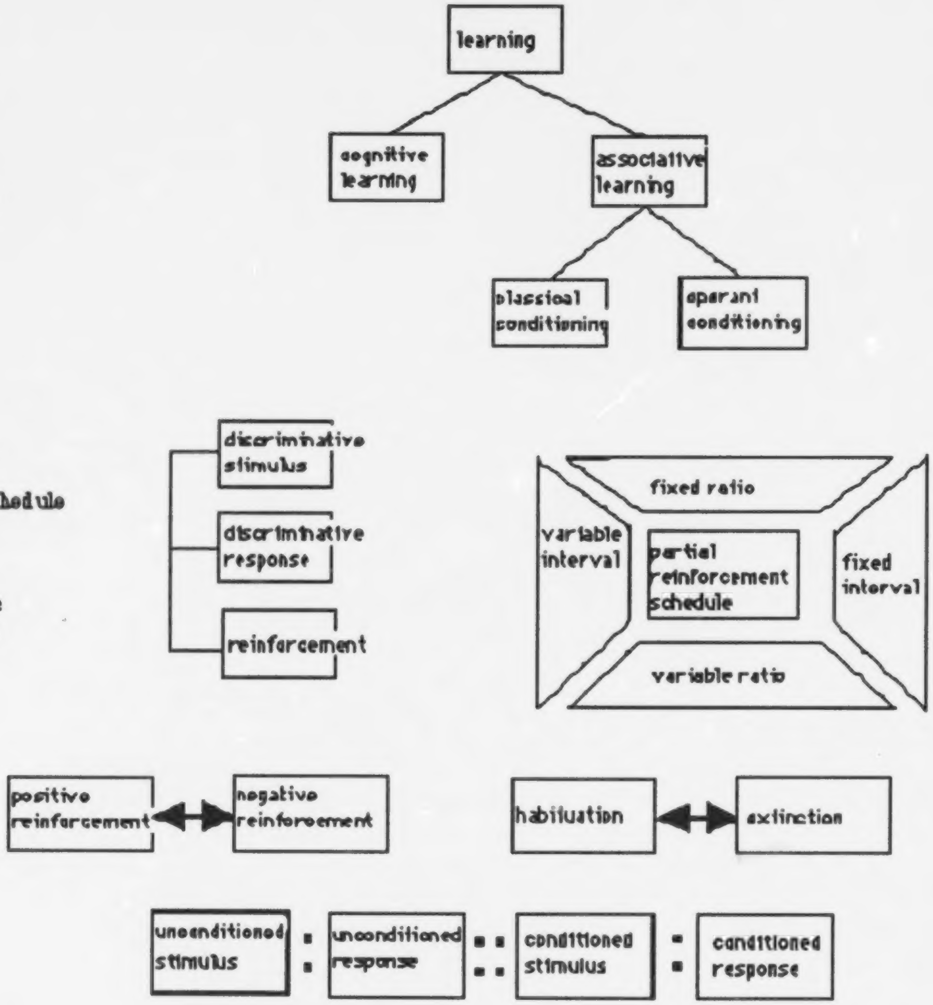
learning
cognitive learning
associative learning
classical conditioning
operant conditioning
discriminative stimulus
discriminative response
reinforcement
fixed ratio
variable interval
partial reinforcement schedule
fixed interval
variable ratio
positive reinforcement
negative reinforcement
habituation
extinction
unconditioned stimulus
unconditioned response
conditioned stimulus
conditioned response

Figure 2

Procedure

The study was a quasi-experimental design using intact psychology classes. The classes met three times a week at 10:00 (Group 1) and 1:00 PM (Group 2). One of the researchers served as instructor for both sections of the course.

A counterbalanced design was used to control for practice effect and chapter difficulty.

	Group 1	Group 2
Exam 1: Baseline	Chapters 1, 2	Chapters 1, 2
Exam 2: Maps Provided	Chapters 3, 4	Chapters 6, 7
Exam 3: Maps Generated	Chapters 6, 7	Chapters 3, 4

One week prior to Exam 1, a study sheet containing the key terms from lecture and text was distributed. Exam 1 was administered to both groups at the beginning of the 4th week of class. It covered chapters 1 and 2 (history & methodology) and served as the within-group control measure.

At the end of the 4th week (2 sessions after Exam 1) the investigators informed the students that they would be involved in a study about using learning strategies that would help them improve their learn skills.

One week prior to Exam 2, a list of key terms and an instructor-generated map of terms (graphical organizer, Figure 3) was distributed to students; 30 minutes of class time was devoted to explaining the mapping rationale. Exam 2 was administered at the beginning of the 8th week of class. Group 1 was tested on chapters 3 and 4 (physiology, sensation & perception); Group 2 was tested on chapters 6 and 7 (learning & memory). During the class period following the exam, the instructor reviewed the exam and administered a questionnaire assessing the extent of use and helpfulness of the instructor-provided maps.

A week prior to Exam 3, a list of key terms and a student-generated mapping exercise were distributed to students; 30 minutes of class time was devoted to the procedure of generating maps. Students were assigned to complete the maps for homework. The following class period, the student-generated maps were collected. They were evaluated on a 9-point Likert scale and returned at the next class, which was devoted to review and to helping students complete the maps of difficult items. Then students were given copies of the same maps which had been distributed to their counterparts for Exam 2. Exam 3 was administered at the start of the 12th week of classes. Group 1 was tested on chapters 6 and 7 (learning & memory); Group 2 was tested on chapters 3 and 4 (physiology, sensation & perception). During the class period following the exam, the instructor reviewed the exam and administered a questionnaire assessing the extent of use and helpfulness of the student-generated and instructor-provided maps.

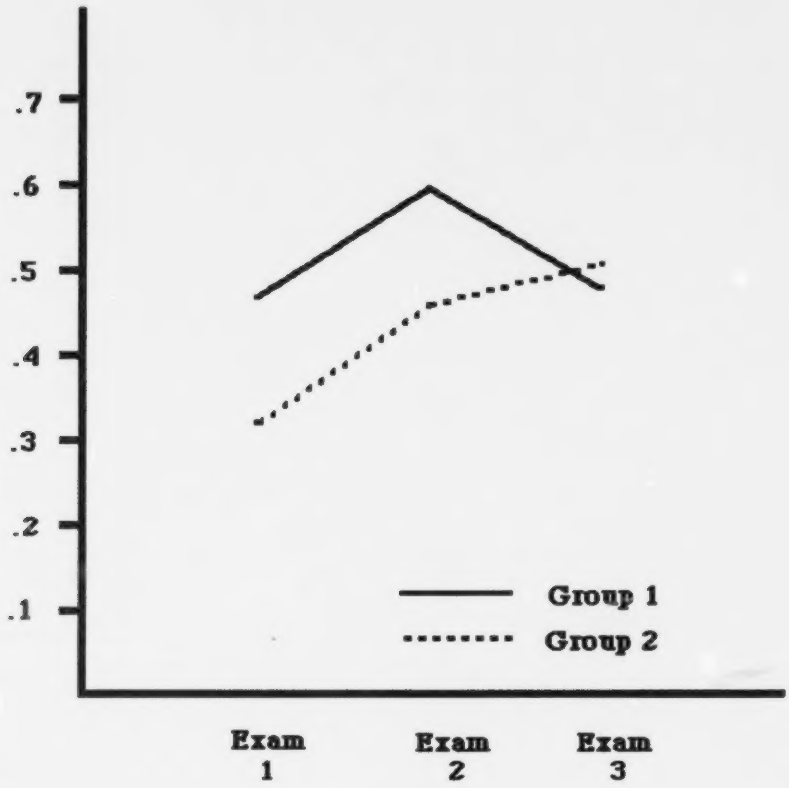

Figure 2
Mean Proximity Correlations by Exam

Figure 2

Results

The semantic proximity scores for each of the students completing all three exams were correlated with the expert ratings, yielding a correlation coefficient for each subject. These coefficients and the relationship scores (0-8), analogy scores (0-5), and the recall/comprehension items (0-37) were all analyzed using a repeated measures analysis of variance (ANOVA). The means for the proximity scores by group are illustrated in Figure 3, and the relationship and analogy scores are illustrated in Figure 4.

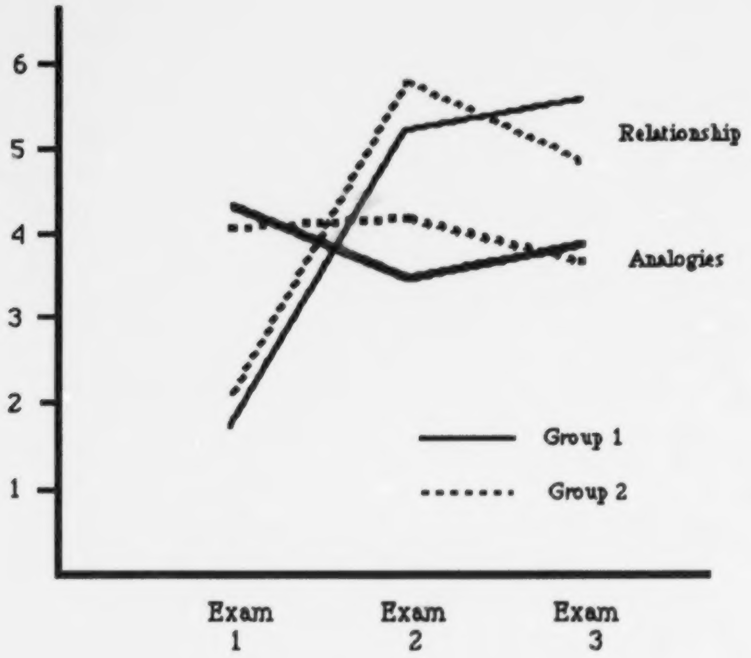

Figure 3
Relationship and Analogy Scores by Exam

The ANOVA calculated on the proximity correlations indicated that Group 1 significantly outperformed Group 2 (Table 1). This was especially true on the first and second exams. Note that this question type was new to students on the first exam. Howeve, a significant interaction occurred between the second and third exams. Group 1 appeared to be adversely affected by the generative learning strategy which appears to have significantly benefitted Group 2 students.

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Group (A)	1	.601	.601	4.432	.0402
subjects w. groups	51	6.915	.136		
Repeated Measure (B)	2	.348	.174	2.274	.1081
AB	2	.72	.36	4.713	.011
B x subjects w. groups	102	7.797	.076		

Table 1
ANOVA on Mean Proximity Correlations

On the relationship scores, no main effect for group occurred; however, a significant main effect occurred for the repeated measures (Table 2). It is obvious from Figure 4 that both groups improved their relationship knowledge by focusing on the relationships when using the instructor-provided graphic organizers. Structural knowledge acquisition improved significantly. Between the second and third exams, an apparent task-by-group interaction occurred ($p<.05$). Group 1 relationship scores appear to have benefitted more from the learning strategy than Group 2 scores.

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Group (A)	1	.183	.183	.074	.7865
subjects w. groups	51	126.043	2.471		
Repeated Measure (B)	2	414.503	207.252	128.225	.0001
AB	2	13.966	6.983	4.32	.0158
B x subjects w. groups	102	164.864	1.616		

Table 2
ANOVA on Relationship Scores

The analogy scores changed significantly across exams. Group 2 increased, then decreased, while Group 1 decreased then increased. A similar interaction effect occurred on the analogy scores (Table 3). Group 1 scores improved significantly from the second to the third exam.

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Group (A)	1	1.484	1.484	.812	.3719
subjects w. groups	51	93.245	1.828		
Repeated Measure (B)	2	20.994	10.497	13.082	.0001
AB	2	17.162	8.581	10.694	.0001
B x subjects w. groups	102	81.844	.802		

Table 3
ANOVA on Analogy Scores

In attempting to explain the effects that occurred in the study, all of the possible factors need to be analyzed. The possible causal factors include the treatment (organizer vs. learning strategy), the content or test difficulty, and individual differences between the groups. There was no significant difference between the groups in terms of their preferences for structuring materials (field independence) as measured by the Hidden Figures Test (Ekstrom, French & Harmon, 1963). There was good reason to believe that content difficulty may be a factor. Group 1 experienced more difficulties on the second exam covering chapters 3 and 4 while Group 2 experienced similar difficulties on the third exam which covered the same chapters.

In order to test this hypothesis, we examined the total exam scores including all of the subscales. Total scores on the exams increased proportionately for both groups from the first to the second exam; however, Group 2 scores decreased significantly on the third exam. This would tend to discount the content difficulty argument. No significant differences in the recall/comprehension scores occurred. Since the strategies focused on the acquisition of structural knowledge, this finding was expected. The interaction between group and repeated measures was significant however (F=4.06, p<.05). The performance for Group 1 was consistent across exams while Group 2 scores decreased significantly on the third exam. This would indicate that either the test and/or the material was more difficult overall or that recall was adversely affected by the learning strategy.

At the end of the seester, students completed a recall/comprehension examination over the entire semester's material. Each of the items in the exam were classified by the exam (and therefore the treatment) they were derived from. These questions comprise a recall/retention test of the content learned under each of the treatments. The retention scores showed the same pattern as all of the structural knowledge questons in the chpater tests. A repeated masure ANOVA showed no main effects but a significant group-by-treatment interaction ($F=17.65$, $p<.001$). Retention scores were equivalent for maerials from the first exam, Group 1 decline on material from the second exam (Chapters 3 and 4, $M=7.7$) and improved on material from the third (Chapters 6 and 7, $M=10.2$) while Group 2 had the opposite effect ($M=10.0$ and 7.4). Clearly, the material from chhapters 3 and 4 was more difficult than that from chapters 6 and 7.

Discussion

A number of factors seem to have affected the learning of material in this experiment. One of the most obvious is the difficulty of the material. Clearly the material in Chapters 3 and 4 (physiology, sensation, and perception) was more difficult than that from Chapters 6 and 7. The former discussion was more technical and less related to the student's prior knowledge. It is easier to relate learning and memory concepts to a class of college students.

However, difficulty of the material was not the only cause of the results. Since immmediate recall and comprehension performance was not appear to be affected by the content for Group 1. Their recall scores were essentially equal. Group 2 however was more affected. In addition to content difficulty, their decreased performance was also caused in part by motivational deficiencies. Group 1 examination performances tended to exceed that of Group 2. This might be explained by any of several factors, or a combination thereof. First is intrinsic motivation. At this college, afternoon classes (Group 2) are generally more lethargic and less academically motivated than morning classes; frequently the students in the afternoon classes enroll just before the term begins (attending college is more of an afterthought). Second is extrinsic motivation. Although students were asked to complete the mapping exercise, they did not receive any course credit for doing so. 13 of 27 students in Group 1, but only 9 of 28 students in Group 2 mapped both chapters for the third exam. Future studies should assign course credit based on the quality of maps generated. Another issue related to extrinsic motivation is the fact that the instructor curved the students' grades on each exam. Thus, the students in Group 1, which scored higher than Group 2, were forced to master more of the material if they wanted to earn high grades. In future studies, grades should not be curved.

Another issue relates to the difficulty of the mapping exercise. The exercise may have placed too great a cognitive load on students. The 30 minutes instruction in completing the maps was probably inadequate; we believe that future studies should provide practice in generating maps of familiar material before students are asked to generate maps of new material. Furthermore, they probably needed more scaffolding in completing such exercises. For example, the list of key concepts should contain only the terms which can actually be used to complete the maps; in this study, students received a list of all of the concepts they were responsible for, but many of these were not addressed by the maps. Since it appears that students acquired more benefit from being provided with completed maps than having to generate their own (these maps provided scaffolding for relating and remembering the material) and generating maps was a new learning strategy for the students, they did not have time to learn how to incorporate this study strategy in just a few days; Duffy and Roehler (1989) suggest that it takes months for a new learning strategy to displace a well-established old one. To give students time to incorporate the strategy into their repertoires, future studies should utilize a single strategy for an entire semester.

Students' reactions to the two strategies also suggests the need for further investigation. At least 77% of the students in each class said they found the maps to be "somewhat helpful" or "very helpful" study aids. But as Clark (1982) found in an earlier study, there appears to be a achievement and enjoyment; 67% of the survey respondents in Group 1 (44% of the total group) preferred being given maps, while 64% in Group 2 (32% of the total group) preferred having to construct maps. Most of the students who preferred being given maps commented that having to complete the maps forced them to pay closer attention to the material. Whether students' preferences and achievement would change with less difficult mapping exercises and more training in mapping must be studied.

Another question relating to the use of the maps is the nature of the cognitive processing students used. Did they engage in rote memorization or perhaps some form of verbal mediation such as self-explanations or comparative elaborations? Future studies should include debriefing sessions to try to identify the types of processing students used.

Students' performances on the relationship items suggests that verbal competency might have played a role. During the exams, several students asked the instructor the definition of words (e.g., "exemplifies"). Future studies should assess students' verbal competency to determine if it influences their performance on the examinations.

Finally is the issue of content difiiculty. For the total scores there was no group by test interaction, but for the structural-knowledge items there was. This suggests that there was an interaction for content by cognitive task difficulty. That is, it may have been more difficult to assimilate structural knowledge for chapters 3 and/or 4 than for chapters 6 and 7. Chapter 4 did not have a single organizing structure; thus no hierarchical map was provided for that chapter; the lack of such a structure may have contributed to the depressed structural knowledge scores on that examination. Further analysis of the content of test items for chapters 3 and 4 is needed.

References

Clark, R. E. (1982). Antagonism between achievement and enjoyment in ATI studies. *Educational Psychologist, 17* (2), 92-101.

Clifford, M. (1981). "The frame game". Supplement to *Practicing educational psychology.* New York: Houghton Mifflin.

Diekhoff, G. M. (1983). Testing through relationship judgements. *Journal of Educational Psychology, 75*, 227-233.

Duffy, G. G., & Roehler, L. R. (1989). In. C. McCormick, G. Miller, & M. Pressley (Eds.), Why strategy instruction is so difficult and what we need to do about it. *Cognitive strategy research: From basic research to educational applications* (pp. 133-154). NY: Springer-Verlag.

Ekstrom, R.B., French, J.W., & Harman, H.H. (1976). *Manual for the kit of factor referenced cognitive tests.* Princeton, NJ: Educational Testing Service.

Jonassen, D.H. (1985). Learning strategies: A new educational technology. *Programmed learning and Educational Technology, 22*(1), 26-34.

Jonassen, D.H., Beissner, K., & Yacci, M. (in press). *Structural knowledge.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Jonassen, D.H., Grabinger, R.S., & Harris, N.D.C. (1991). Instructional strategies and tactics. *Performance Improvement Quarterly, 4*(1),

Schvaneveldt, R.W., Durso, F.T., Goldsmith, T.E., Breen, T.J., Cooke, N.M., Tucker, R.G., & DeMaio, J.C. (1985). *Measuring the structure of expertise.* Las Cruces, NM: Computing Research Laboratory, New Mexico State University.

Shavelson, R. (1974). Methods for examining representations of subject matter structure in students' memory. *Journal of Research in Science Teaching, 11*, 231-249.

Thro, M.P. (1978). Relationships between associative and content structure of physics concepts. *Journal of Educational Psychology, 70*, 971-978.

Wittrock, M.C. (1978). The cognitive movement in instruction. *Educational Psychologist, 15*, 15-29.

Title:

Acquiring Structural Knowledge from Semantically Structured Hypertext

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Acquiring Structural Knowledge from Semantically Structured Hypertext

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Abstract

Hypertext researchers and designers contend that the hypertext information structures may reflect the semantic structures of human memory. Further, they believe that mapping the semantic structure of an expert onto hypertext information structure and explicitly illustrating that structure in the hypertext will result in improved comprehension because the knowledge structures of the users will reflect the knowledge structures of the expert to a greater degree (Jonassen, 1990, 1991b). This reviews techniques for ascertaining an expert's knowledge structure and mapping it onto hypertext. It then reviews the results of three studies that assess the effects of different methods for explicitly mapping expert knowledge structures onto hypertext on the acquisition of structural knowledge in the learners. The studies show that depicting knowledge structures in the form of a graphical browser or by making explicit the structural nature of the links during traversal does not improve learners' acquisition of structural knowledge. However, when assigned the task of generating a semantic network following browsing, structural knowledge acquisition improved significantly. It is theassigned processing task and goals for learning while interacting with a hypertext that appears to most significantly determine the effects of its use on learners' knowledge structures.

INTRODUCTION

Associative Hypertext Structures

Hypertext researchers have recently asserted that hypertext mimics the associative networks of human memory (Fiderio, 1988; Jonassen, 1990, 1991a, 1991b). Bush (1945), who is credited with developing the first prototype hypertext system, observed that ideas result from "the association of thoughts, in accordance with some intricate web of trails carried by cells of the brain". This observation and the continued development of associative network theory have provided a conceptual foundation for the development of hypertexts.

Hypertext, like other technologies such as databases and expert systems, is a knowledge-based system. That is, subject content is stored in a knowledge base which is structured by a particular *data model*, which defines the organization of the information contained in the knowledge base. This organization, in turn, defines the logical relationships between the content units in the knowledge base. The logic in each type of data model varies with the kinds of relationships that comprise it. A hypertext engine, on the other hand, is associative. That is, it is based upon an associative network of ideas. Links may be defined by an open set of associations, so hypertext structures may take on a variety of forms. Therefore, the structure of any hypertext may emulate the logical structures of a variety of instructional designs or functions (Jonassen, 1991b).

The belief that hypertext can mimic human associative networks implies that an appropriate method for structuring hypertext is to mirror the semantic network of an experienced or knowledgeable performer or expert. Semantic networks are rooted in schema theory (Rumelhart & Ortony, 1977). Personal knowledge is stored in information packets or *schemas* that comprise our mental constructs for ideas. Schemas have attributes, which they share with other schemas. Each schema that we construct represents a mini-framework in which to interrelate elements or attributes of information about a topic into a single conceptual unit (Norman, Gentner, & Stevens, 1976). These mini-frameworks are organized by the individual into a larger network of interrelated constructs known as a semantic network. These networks are composed of nodes (representations of schemas) and ordered labelled relationships that define the propositional relationships between them (Norman, Gentner & Stevens, 1976).

The general hypotheses for these studies is that mapping the semantic network of an expert or knowledgeable person onto the structure of a hypertext will contribute to the development of the learners' knowledge structures while using the hypertext to learn.

Learning consists of building new knowledge structures by assimilating environmental information and constructing new nodes that describe and interrelate them with existing nodes and with each other (Norman, 1976). The interrelated knowledge reflected in semantic networks enables humans to combine ideas, infer, extrapolate or otherwise reason with the information. Learning requires the formation of links between existing knowledge and new knowledge in order to comprehend information from the environment. Learning therefore may be conceived of as a reorganization of the learner's knowledge structure that results from the learner's interactions with the environment. However, learning is also influenced by intentional instruction. Research has shown that as a result of teaching, learners' knowledge structures more closely resemble the instructor's (Shavelson, 1974; Thro, 1978), that is, learners acquire the teachers knowledge structure, which in turn improves comprehension. So, learning is the linking of new information with exisiting knowlege, a process which is influenced by the mapping of the teacher's or expert's subject matter knowledge onto the learner's knowledge structure. This conception provides the rationale for mapping the expert's knowledge structure onto learning environments, such as hypertext.

Hypertext engines or structures can be designed to reflect the semantic structure of a subject matter expert. The assumption for doing so is, "if the node-link structure of the hypertext reflects the semantic structure of the expert, the expert's knowledge structure may be more effectively mapped onto the novice browser, thereby improving comprehension." This is the assumption that has been investigated in the studies described below.

EXPERIMENT 1

The most direct way to map the expert's semantic structure onto a hypertext is to use the expert's semantic map as a graphical browser in the hypertext. Graphical browsers are maps or graphical listings of available nodes in a hypertext. They represent a graphical interface between the user and a hypertext that is designed to reduce navigation problems within the hypertext (Jonassen, 1988). Getting lost in a large web of hypertext nodes and links is a commonly reported problem among hypertext users, so graphical browsers are used to provide a spatial orientation to the available nodes in a hypertext. When arranging the nodes in a graphical browser according to an expert's semantic map, the hypertext is explicitly conveying the organization of ideas in the expert's knowledge structure. So, while navigating through a hypertext, the user is in effect navigating through the expert's knowledge structure. The research questions in this study focus on the extent to which the semantic structure illustrated in graphical browsers actually maps onto the user's knowledge structure. To what extent will the user model or replicate that structure in their own knowledge representations?

Method

Sample

This study involved undergraduate pre-service teachers in a teacher education program

Instruments

In order to assess the effects of semantically structured hypertext on learner's knowledge structures, it was necessary to develop instruments that assessed the learners' *structural knowledge*. Structural knowledge is the knowledge of how concepts within a domain are interrelated (Diekhoff, 1983). Structural knowledge enables learners to form the connections that they need to describe and use scripts or complex schemas. It is a form of conceptual knowledge that mediates the translation of declarative knowledge into procedural knowledge.

In order to assess structural knowledge acquisition following various treatments, we developed three subscales of ten questions each to measure different aspects of structural knowledge: a) relationship proximity judgements, b) semantic relationships, and c) analogies. All of the structural knowledge test questions were developed to focus on relationships between important concepts contained in the hypertext.

The relationship proximity judgements required that students assign a number between 1 and 9 to each of several pairs of concepts to indicate how strong a relationship they thought existed between the concepts in each pair (Diekhoff, 1983; Schvaneveldt, Durso, Goldsmith, Breen, Cooke, Tucker & DeMaio, 1985; Shavelson, 1974). For example:

_____ information retrieval systems and online documentation

_____ hypertext processing strategies and database

The semantic relationships subscale consisted of multiple choice questions that required students to identify the nature of the relationship between two concepts. These relationships were paraphrased from the hypertext knowledge base. For example:

_____ unstructured hypertext ..... navigating hypertext

a. produces problems in
b. defines the functions of
c. counteracts the effects of
d. enabled by

Finally, the analogies subscale required students to complete 10 analogies consisting of four of the concepts from the hypertext. For example:

_____ accessing information : index :: integrating information : ......

a. links
b. hypermaps
c. idea generator
d. multi-user access

These questions were used to assess structural knowledge acquisition. In order to provide standards for assessment, three authors and researchers in the hypertext field agreed on the answers to each of these questions. In addition to assessing structural knowledge, ten lower-order information-recall questions were developed.

Materials

The hypertext that was used was the HyperCard version (Jonassen, Roebuck & Wang, 1990) of the book *Hypertext/ Hypermedia* (Jonassen, 1989a). This hypertext is a browsing system consisting of 240 cards and 1167 links in three stacks supported by bookmarking and limited annotation capabilities. All treatments in all studies contained embedded referential links in the cards. Terms in the text were highlighted, enabling learners to immediately traverse the links. The treatments varied in terms of the types of browsers that were made available and the ways that they depicted structural information. Each of the 75 major concept nodes contained a main "related terms" card, which was the first card accessed when traversing a link to that node. In the control group, this card provided a list of terms that are related to the concept being currently examined. This list provided links but no structural information about the nodes or links. The experimental treatments (described in more detail below) replaced these lists with graphical browsers or retained the lists but overtly communicated the nature of each link when it was being traversed. They were to designed to provide or require the learner to generate explicit structural information about the nodes and links in the hypertext.

In this study, we compared the extent to which users acquire structural knowledge by using a graphical browser vs. a pop-up window mediating each link. Each graphical browser showed the current node and all nodes linked directly to it and explicitly depicted the nature of the relationship between each of those nodes (see Figure 1 for an example). Each of the icons in the graphical browsers were hot buttons which the learners used to navigate through the hypertext. In order to navigate the hypertext, users would click on any icon to traverse the link to that topic.

In the second experimental treatment, the same nodes related to the current node were presented in list form with no indication of the nature of the relationship between the nodes. In order to traverse a link, users simply clicked on a term. Whenever the user clicked on a term to select it, that is to navigate that link, a window filling 70% of the screen area would pop up. The text in this pop-up window stated the explicit relationship between the node the learner was leaving and the node the learner was going to. So, whenever the student traversed a link between the existing and the target node, a pop-up window stated explicitly the relationship between the node they were leaving and the one they had selected, providing an explicit statement of structural knowledge.

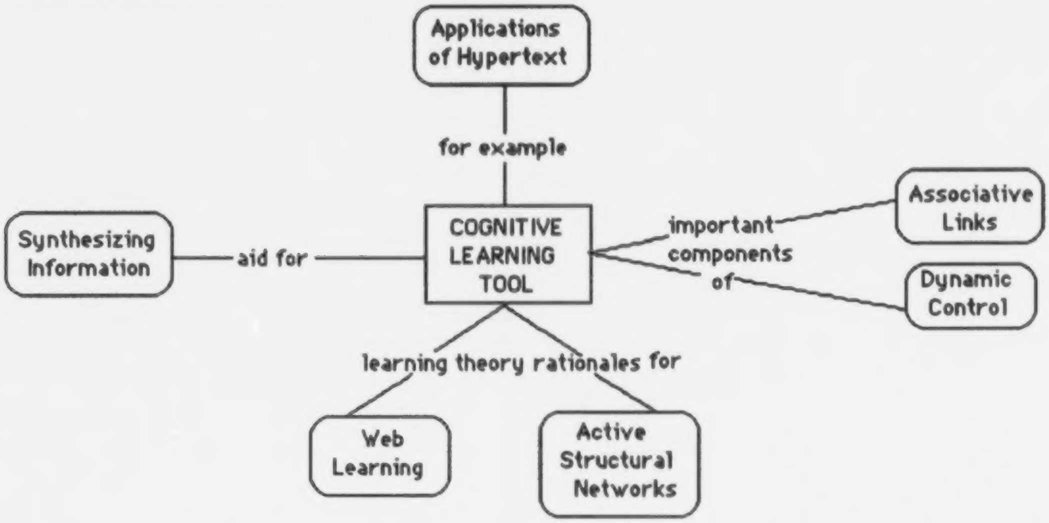

Figure 1
Graphical Browser

Both experimental conditions provided structural information to the student. The graphical browser treatment illustrated the organization of information in the hypertext knowledge base, while the pop-up treatment explicitly depicted relationships on a node-by-node basis. In order to navigate the hypertext, the control group students were provided the lists of of related terms with no indication of the nature of the relationship between the nodes. In order to traverse a link, users simply clicked on a term.

Procedure

Students were given the task of learning about an important new instructional technology, hypertext, as an assignment in a pre-service instructional technology course by using a hypertext. In a Macintosh laboratory, students individually interacted with and studied the hypertext in order to acquire as much information about this new technology as possible. A monitoring program was added to the stacks to audit the action and the time allotted to each of the student's actions. Following the interaction, learners were asked to complete the posttests.

Results

The dependent variables in the cognitive domain in this study were the recall, relationship, proximity, and analogy subscales of the posttest. The only independent variable was the version of the treatment administered to each of the subjects. The recall (15 items), relationship (10 items), and analogy (10 items) subscales were totaled for each subject. The means are presented in Table 1. For the proximity scores, correlation coefficients were calculated for each subject, in which the proximity ratings of the subject were correlated to the proximity ratings of a panel of three experts. The means for these coefficients by group are presented in Table 1.

	Recall Time	Proximity Struc. Cards	Relationship		Proximity		Analogy
Treatment							
Control	7.8 (2.1)	.295 (.2)	5.4 (2.3)	.572 (.08)	3.0 (1.3)	57.2	27.5
Pop-up	7.4 (2.1)	.333 (.2)	5.6 (1.7)	.616 (.12)	2.7 (1.9)	50.8	45.9
Map	6.6 (1.9)	.320 (.2)	5.0 (2.2)	.583 (.08)	3.1 (1.6)	51.2	53.2

Table 1
Means (Standard Deviations) of Dependent Variables by Group

Table 1
Means (Standard Deviations) of Dependent Variables by Group

One way analyses of variance were calculated for each of the four dependent variables. The only dependent variable with even a marginally significant difference was the recall variable (*F*(2,93)=2.75, p<.07). A post hoc analysis using a Fisher LSD test showed that the only groups which were significantly different were the control and the map versions, with the control group outperforming the map version (*LSD*=1.15). The map version produced the lowest scores overall.

Time on task was also compared by group. Control group students spent the longest amount of time (*M*=57.3 minutes) while the pop-up group spent only 50.7 minutes. Because of the large standard deviations in the amount of time spent within group, this difference was not significant.

The total number of structurally related cards accessed by students was also calculated. Structural cards were the maps (Map group) or the lists in the other experimental group and the control group. These cards contained the structural information that defined the relationships between the nodes on the knowledge base. The number of structural cards accessed was different between groups (*F*(2,93)=3.75, p<.05) while the total number of cards accessed and the total time spent viewing structural cards did not differ significantly. The control group accessed 106 cards while the pop-up and map groups accessed 85 and 92 cards respectively.

The absence of main effects for structural knowledge outcomes did not necessarily mean that no structural coding occurred. In order to assess the role of structural cueing on structural knowledge, regression analyses were calculated. The total umber of cards accessed while reading the hypertext was regressed onto each of the dependent variables. No significant differences occurred. However, when the number of structural cards accessed was regressed on the dependent variables, significant differences occurred. The number of high level structural cards (main map and eight first level maps, eg. Characteristics of Hypertext) that were accessed by students significantly predicted the relationship scores (*F*=3.7, p=.05). The number of structural cards accessed also significantly predicted the time spent (*F*=5.37, p<.05). The fewer the structural cards that were accessed, the more time that was spent by the students reviewing the knowledge base.

Total time spent interacting with structural cards was also calculated by group. The time spent on structural cards did not significantly regress on any of the dependent variables. The average proximity scores showed an effect of time, although this effect was not significant (p<.10).

Discussion

The lack of significant main effects in performance indicates that the information processing required by browsing hypertext overshadowed the design attributes of the interface. The control treatment, which did not provide explicit structural information, produced the highest level of recall. This finding is consistent with research that shows that without cueing or practice, learners tend to recall micropropositions more readily than macropropositions.

There were a number of potential limitations of this study that may have obviated more consistent structural effects. First, the average time spent interacting with this hypertext was less than one hour for virtually all subjects. This short treatment period did not provide adequate exposure to the hypertext or its structural elements. In the follow-up study, incentives will be used to increase the length of the interactions with the hypertext.

In addition to the limited exposure to the hypertext, the lack of hypertext processing strategies (Jonassen, 1989) likely precluded the most effective use of the technology. Hypertext, and the greater control of instruction that it requires, is a novel form of instruction for these learners. The more novel the appearance of the hypertext (ie. mapping version), the more negatively the students reacted to it. A fair evaluation of learning from hypertext can only come from hypertext-literate learners who have developed a useful set of strategies for navigating and integrating information form hypertext.

The novel form of instruction, hypertext, was only exacerbated by the novel structural cues and structural learning outcomes. The explicit provision of structural information is unusual to these students. The requirement to process that information and integrate it into their own knowledge structures was even more novel to them, which negatively affected their performance on the tasks. As evidenced by the floor effect on the analogy questions, these students were not accustomed to higher order, structural knowledge outcomes from instruction. The poor performance of learners on higher order and structural knowledge tasks washed out most of the treatment effects. The relationship test resulted in only one half of the questions answered correctly and less than one third on the analogy tests. Only one half of the paraphrased recall questions were answered correctly. Perhaps verbatim recall questions may have been better answered. This calls into question the ability of learners to acquire knowledge from hypertext in the context of a learning assignment.

A major reason for the lack of main effects in this study as well as the limited potential of hypertext for learning is the lack of generativity in the processing of the information. Wittrock (1974) claimed that meaningful learning results form generative processing in which learners relate new information to their existing knowledge in order to accommodate it to ha they know already. Merely attending to structural cues may not engender generative processing of information. In the next study, the structural cues will be compared with a more generative process in which the students must determine the nature of the link relationships for themselves, rather than being informed by the program.

The post hoc regression analyses provided some evidence that students were in fact attending to some of the structural information. The number of structural cards accessed appeared to predict structural knowledge acquisition in the form of relationship judgements in two different forms. The time spent with the structural cards suggested a relationship between accessing those cards and the level of structural knowledge acquisition. These are weak effects at best, though with longer exposure to the hypertext and the prior acquisition of some hypertext processing strategies should clarify those effects.

Hypertext is an information retrieval technology that may have implications for instruction. If it is to fulfill that potential, then designers must verify methods for facilitating the learning

EXPERIMENT 2

Generative Processing of Structural Information

Perhaps the most significant weakness of the first study was the lack of instructional support provided the learner., given the expectations of learning from the hypertext. Hypertext is a technology that supports information retrieval and search tasks. However, these tasks are not necessarily predictive of learning. The most significant potential problem in learning from hypertext is integration of the information that is browsed into the learner's knowledge structure (Jonassen, 1989a). Learning requires that users not only access information but also interpret it by relating it to prior knowledge, as discussed in the introduction.

Method

Subjects

112 students enrolled in an undergraduate course in instructional technology at a western college participated in this study. The students are enrolled in a teacher certification program.

Instruments and Materials

The instruments used were identical to Experiment 1. However, the treatments were altered. Three treatments were developed for this study using the same HyperCard version (Jonassen, Roebuck & Wang, 1990) of the book *Hypertext/ Hypermedia* (Jonassen, 1989) that was used in Experiment 1. The second study attempted to provide additional instructional support by including a more generative form of treatment. Generative learning occurs when learners relate information meaningfully to prior knowledge (Wittrock, 1974). This study included a generative processing treatment. Rather than being told what the nature of the relationship was between the nodes being linked, the learners were required to classify the nature of each link themselves. The pop-up window presented 12 different link types and required the learner to determine which of the link types most accurately depicted the nature of the relationship implied by the link that they were traversing. The user had the option of returning to the previous node or moving forward to see the node they had selected as many times as necessary. Knowledge of results was provided for each selection by the user until the user selected the correct link type.

The control treatment, consisted of embedded referential links in the cardsin addition to the "related terms" nodes attached to the 75 major concepts. The first experimental treatment consisted of the same capabilities with the added feature of a pop-up window mediating each link, as in Experiment 1. Text in the window stated the explicit relationship between the node the learner was leaving and the node the learner was going to whenever the student traversed a link between the existing and the target node (an explicit statement of structural knowledge). The second experimental treatment, the generative treatment, used a pop-up window which asked the student to classify the nature of the relationship between the node they were leaving and the one they were traversing to. Students were provided the option of reviewing the pervious node and the target node in order to help classify the relationship. The first experimental condition provided structural information to the student, and the second required the learner generate his/her own relational information.

Procedure

Students were given the task of learning about an important new instructional technology, hypertext, as an assignment in a pre-service instructional technology course by using a hypertext. In a Macintosh laboratory, students individually interacted with and studied the hypertext in order to acquire as much information about this new technology as possible. A monitoring program was added to the stacks to audit the action and the time allotted to each learner action. Following the study period, learners completed the posttests.

Results

As in the first study, the recall scores of the control group (no structural information provided) were higher than either of the two structural treatments, however, this difference only approached significance (p=.06). No differences between relationship, proximity judgements, semantic relationships, or analogy scores occured. As anticipated, recall scores were higher in the control group, but neither structural strategy produced any increase in structural knowledge acquisition.

Treatment	N	Recall	Proximity	Relationship	Analogy
Control	21	5.38 (1.5)	-.144 (.25)	5.10 (1.5)	2.95 (1.3)
Pop-Up	22	4.90 (1.4)	-.088 (.25)	5.73 (1.5)	2.68 (1.6)
Generative	24	4.42 ((1.2)	-.055 (.24)	5.75 (1.6)	2.75 (1.5)

Table 2

In this study, we also assessed the individual difference characteristics, field independence (Hidden Figures Test) and global reading ability/vocabulary (Extended Range Vocabulary Test, both from the Kit of Factor Referenced Cognitive Tests (Ekstrom, French, & Harman, 1976) looking for aptitude-by-treatment interactions. Marginally significant interactions occurred on the recall and relationship variables. In the control and generative treatments, field independent students performed better on the recall task, but they were impeded by the pop-up version. On the semantic relationship task, the opposite occurred. Field independent students in the pop-up version outperformed field dependents while theregression equations for the control and generative groups were flat. No significant interactions occurred on the analogy task. Nor were there any interactions of treatments with vocabulary scores.

EXPERIMENT 3

While instructional tasks are normally thought to be an important predictor of integration of information into knowledge structures (although this was not entirely evident from Experiment 2), probably the most important determinant of learning is the awareness and understanding of the required task or learning outcome. In the previous two studies, it became clear that learners were not certain how to "learn from hypertext". Students in these studies were most familiar with performing specific, convergent, recall-oriented learning tasks. The uncertainty involved in trying to integrate knowledge by focusing on structural relationships when the task was not clear became obvious throughout the course of experimentation. It was also clear from the first two studies that students, based upon their scores on the relationship and analogy tests, were not familiar or competent with structural knowledge tasks. So, the third study provided a more deliberate structural knowledge focus by using semantic networking as a practice and evaluation strategy.

Semantic Networking as an Integrative Strategy

The process of browsing a hypertext models the accretion process in learning (Rumelhart & Norman, 1978). However, a significant problem in learning from hypertext is the integration of what is acquired while browsing into the learner's knowledge structure (Jonassen, 1989b) and the restructuring of thos knowledge structures (Rumelhart & Norman, 1978). Therefore, it may be necessary to provide integration and restructuring activities to browsing in order to ensure learning from hypertext. Semantic networking software may be used as a cognitive learning strategy (Jonassen, 1989) to help learners integrate information from hypertext. Supplementing browsing activity with a semantic networking activity my provide the learner with a tool for integrating information into their knowledge structure. This process of semantic networking also elicits the process of restructuring.

Method

The third study was conducted to assess the role of semantic networking as a cognitive learning strategy to facilitate structural knowledge acquisition. This study assigned a group of the students the responsibility of constructing a semantic network about the topic of the hypertext following the study period. The other half were told only to study the hypertext to acquire knowledge during the study period.

This third study included a second factor, the type of structural knowledge support. The second factor split both treatment groups into control treatment (no structural cues) and the graphical browser treatment, as in the first study.

Subjects

48 graduate students enrolled courses in instructional technology at a western college participated in this study. These students were enrolled in teacher education and instructional technology programs.

Instruments and Materials

The assessment instruments used in this study were identical to those used in Experiments 1 and 2. Two treatments were developed for this study using the same HyperCard version (Jonassen, Roebuck & Wang, 1990) of the book *Hypertext / Hypermedia* (Jonassen, 1989) that was used in Experiments 1 and 2. The control treatment, consisted of embedded referential links in the cards in addition to the "related terms" nodes attached to the 75 major concepts. Links were presented in list form without any structural information, as in Experiments 1 and 2. The experimental treatment provided users with graphical browser to use for navigation.. Each graphical browser showed the current node and all nodes linked directly to it and explicitly depicted the nature of the relationship between each of those nodes (see Figure 1 for an example). Each of the icons in the graphical browsers were hot buttons which the learners used to navigate through the hypertext. In order to navigate the hypertext, users would click on any icon to traverse the link to that topic.

The second experimental factor investigated the effects of providing a semantic networking learning strategy to the hypertext. In the experimental treatment, we informed learners that they would be required to develop a semantic network about the topic of the hypertext following browsing and studying the hypertext. Learners were provided with with the semantic networking program, Learning Tool (Kozma, 1987). They had perviously learned how to use this tool (see Figure 2 for example).

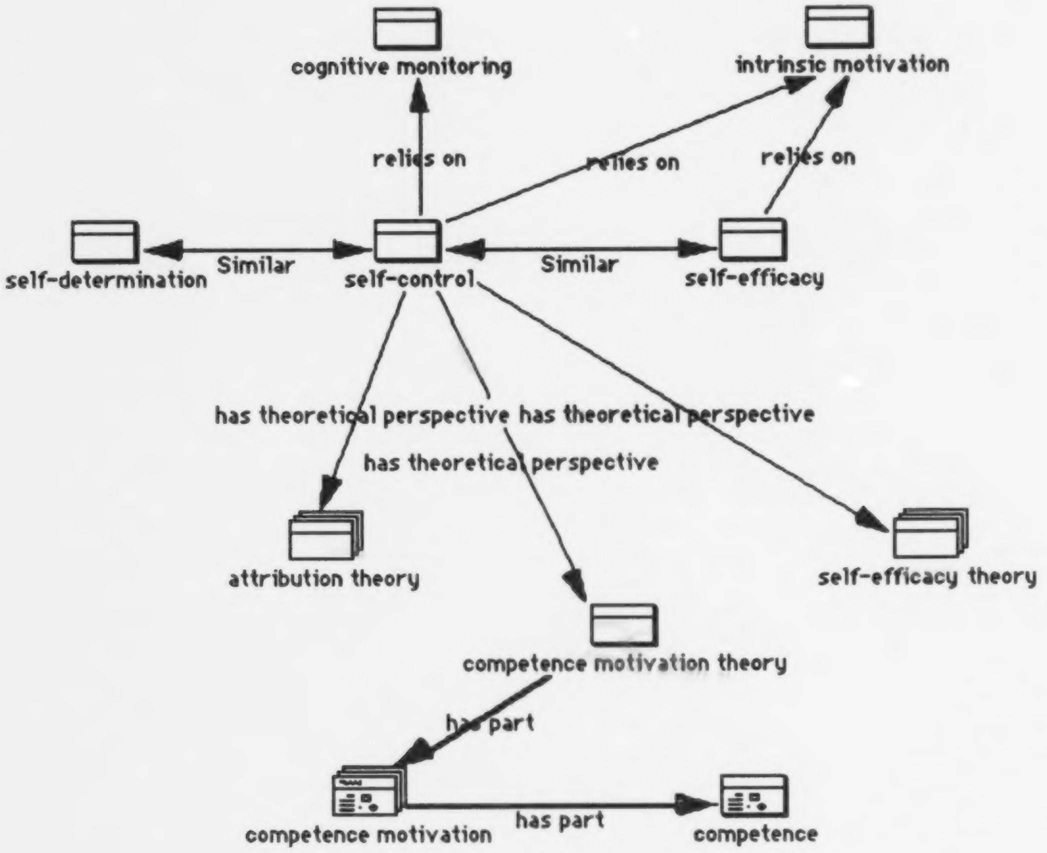
cognitive monitoring
intrinsic motivation
relies on
relies on
relies on
self-determination
Similar
self-control
Similar
self-efficacy
has theoretical perspective
has theoretical perspective
has theoretical perspective
attribution theory
self-efficacy theory
competence motivation theory
has part
competence motivation
has part
competence

Figure 2

Procedure

Students were given the task of learning about an important new instructional technology, hypertext, as an assignment in their instructional technology course by using a hypertext. In a Macintosh laboratory, students individually interacted with and studied the hypertext in order to acquire as much information about this new technology as possible. A monitoring program was added to the stacks to audit the action and the time allotted to each learner action. The exerimental group was told that they would be responsible for developing a semantic network, however, this activity was ceased after only a few minutes. The treatment was developed to focus their attention on structural information in the hypertext. Learning effects were assessed, as in the other studies, immediately following treatment and before any semantic nets were created, so time-on-task did not differ for the groups.

Results. In the third study, learners who were given the task of creating a semantic network performed significantly better on the relationship judgements task than the two groups instructed only to study the materials , F=7.82, p<.01. See Table 3 for means. This result indicates that by focusing the learner's attention on structural aspects of the information in the hypertext, structural knowledge acquisition improved significantly.

	Hypertext Version	
Treatment	Control	Graphical Browser
Read Only	4.67(1.3)	5.7 (1.8)
Semantic Net	6.3 (1.7)	6.7 (1.8)

Table 3

Neither the difference between the form of the hypertext or the interaction were significant. No differences in recall scores were found. However, a one factor ANOVA comparing scores between the four treatment groups indicated that the graphical browser/semantic networking group performed significantly better on the analogy subscale, $F=2.77, p=.05$. It appears that the visual support of the graphical browser in addition to focusing on structural relationships enhanced the comparisons necessary for completing analogies.

DISCUSSION

Conclusions and discussion from these three studies will be considered together. Several issues regarding the use of hypertext for learning and the enhancement of structural knowledge acquisition emerged from these studies.

Attention to Structural Information

The evidence indicates that to the extent that learners attended to the structural cues provided in the hypertexts, they did acquire some structural knowledge. The post hoc regression analyses showed that students were in fact attending to some of the structural information. The number of structural cards accessed appeared to predict structural knowledge acquisition in the form of relationship judgements in two different forms. The time spent with the structural cards suggested a relationship between accessing those cards and the level of structural knowledge acquisition. These were weak effects, though with longer exposure to the hypertext and the prior acquisition of hypertext processing strategies, these findings may be substantiated.

The most questionable assumption of our hypotheses, based upon the results, is that merely providing structural cues in the user interface will result in structural knowledge acquisition. The fact that control treatments produced the highest level of recall is consistent with research that shows that without cueing or practice, learners tend to recall micropropositions (detail) more readily than macropropositions. The structural information presented clearly impeded the recall of specific facts by the students in the structural knowledge treatments. However, it did not generally result in greater structural knowledge acquisition. The conclusion is obvious -- merely showing learners structural relationships is probably not sufficient to result in structural knowledge encoding. Requiring structural knowledge outcomes in the form of thew semantic networking exercise is able to produce enhanced acquisition of structural knowledge though. That is, getting learners to focus on structural relationships will enhance structural knowledge acquisition, which supports higher order thinking in the form of analogical reasoning.

Cognitive Limitations of Browsing Behavior

Another related and probable reason for no main effects in structural knowledge acquisition is the "mistaken notion concerning hypertext ....that the arbitrary 'webs' of facts in hypertext systems have much semantic significance" (Whalley, 1990, 63). What matters most in learning is the construction of personally relevant knowledge structures. It appears that arbitrarily imposed semantic nets are not adequate to overcome the personal ones or at least not directly mapped onto the learners. It is becoming increasingly obvious that learning from hypertext must rely on externally imposed or mediated learning tasks -- that merely browsing through a knowledge base does not engender deep enough processing to result in meaningful learning.

According to Whalley (1990), the most natural mode of studying hypertext is browsing. The question raised by these studies is the extent to which unconstrained browsing can support learning goals. Hypertexts are obvious information retrieval technologies. However, retrieval of information is not sufficient by itself to result in meaningful learning. When the goals of accessing information require deeper processing, then deeper processing is more likely to occur. However, simply browsing hypertext is not engaging enough to result in more meaningful learning. It may well be that hypertext is not be very appropriate for highly structured learning tasks, as Duchastel (1990) suggests.

Hypertext Processing Strategies

Students in these studies appeared, as expected, to lack hypertext processing strategies (Jonassen, 1989), which likely precluded the most effective use of the technology. Hypertext, and the greater learner control of instruction that it entails, is a novel form of instruction for these learners. The more novel the appearance of the hypertext (ie. graphical browser version), the more negatively the students reacted to it. A fair evaluation of learning from hypertext can only come from hypertext-literate learners who have developed a useful set of strategies for navigating and integrating information form hypertext. Experiments with learning from hypertext must assume the responsibility of preparing learners to use this relatively novel technology before studying its effects.

Structural Knowledge Acquisition

The novel form of instruction, hypertext, was only exacerbated by the novel structural cues and structural learning outcomes. The explicit provision of structural information was unusual to these students. The requirement to process that information and integrate it into their own knowledge structures was even more novel to them, which negatively affected their performance on the tasks. The poor performance of learners on higher-order, structural knowledge tasks washed out most of the treatment effects. This calls into question the ability of learners to engage in meaningful learning rather than information retrieval from hypertext, especially in the context of a learning assignment. Clearly when students used structural knowledge learning strategies, they can improve their structural knowldge acquisition.

Individual Differences and Learning from Hypertext

As expected, individual differences interacted with learning from hypertext. Field independent processors generally prefer to impose their own structure on information rather than accommodate the structure that is implicit in the materials. In the second study, field independent learners were impeded by the structural information provided in completing the recall task. However, on structural knowledge outcomes, they were the only learners able to successfully use the structural cues to acquire more structural knowledge information than field dependent learners. It is likely that field independent learners are better hypertext processors, especially as the form of the hypertext becomes more referential and less overtly structured.

References

Bush, V. (1945). As we may think. *Atlantic Monthly, 176*(1).101-108.

Buzan, T. (1974). *Use both sides of your brain*. New York: Dutton.

Diekhoff, G. M. (1983). Testing through relationship judgements. *Journal of Educational Psychology, 75*, 227-233.

Ekstrom, R.B., French, J.W., & Harman, H.H. (1976). *Manual for the kit of factor referenced cognitive tests*. Princeton, NJ: Educational Testing Service.

Fiderio, J. (1988). A grand vision. *Byte*, (October), 237-243.

Fields, A. (1982). Pattern notes: How to get started. In D.H. Jonassen (Ed.), *The technology of text: Principles for structuring, designing, and displaying text*, Vol. 1. Englewood Cliffs, NJ; Educational Technology Publications.

Fisher, K.M., Faletti, J., Thronton, R. Patterson, H., Lipson, J., & Spring, C. (1988). *Computer-based knowledge representation as a tool for students and teachers*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA, April, 1988.

Jonassen, D.H. (1987). Assessing cognitive structure: Verifying a method using pattern notes. *Journal of Research and Development in Education, 20* (3), 1-14.

Jonassen, D.H. (1988). Designing structured hypertext and structuring access to hypertext. *Educational Technology, 28* (10), 13-16.

Jonassen, D.H. (1989a). *Hypertext/hypermedia*. Englewood Cliffs, NJ: Educational Technology Publications.

Jonassen, D.H. (1989b). Mapping the structure of content in instructional systems technology. *Educational Technology, 29*(4).

Jonassen, D.H. (1990). Knowledge elicitation tools for structuring hypertext. In C. Green & R. McAleese (Eds.), *Hypertext: Theory into practice*, Vol. II. London: Blackwell.

Jonassen, D.H. (1991a). Hypertext as instructional design. *Educational Technology: Research and Development, 39* (1),

Jonassen, D.H. (1991b). Representing the expert's knowledge in hypertext. *Impact Assessment Bulletin, 9* (1), 1-13.

Jonassen, D.H. & Mandl, H. (1990). *Designing hypermedia for learning*. Heidelberg: Springer-Verlag.

Jonassen, D.H., Roebuck, N, & Wang, S. (1990). *Hypertext/ hypermedia* (HyperCard Version). Englewood Cliffs, NJ: Educational Technology Publications.

Jonassen, D.H. & Wang, S. (1990).*Conveying structural knowledge in hypertext knowledge bases.* Paper presented at the annual meeting of the Association for the Development of Computer-based Instructional Systems, San Diego, CA, October 30-31, 1990.

Jonassen, D.H. & Wang, S. (1991). *Conveying structural knowledge in hypertext knowledge bases.* Paper presented at the annual meeting of the Association for Educational Communications and Technology, Orlando, FL, February 14-17, 1991.

Kozma, R.B. (1987). The implications of cognitive psychology for computer-based learning tools. *Educational Technology, 28*
(11), 20-25.

Norman, D. A. (1976). *Studies in learning and self-contained education systems*, 1973-1976. Tech Report No. 7601. Washington, D.C.: Office of Naval Research, Advanced Research Projects Agency. (ED 121 786)

Norman, D.A., Gentner, S. & Stevens, A.L. (1976). Comments on learning schemata and memory representation. in D.Klahr (Ed.), *Cognition and instruction*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Preece, F.F.W. (1976). Mapping cognitive structure: A comparison of methods. *Journal of Educational Psychology, 68*, 1-8.

Schvaneveldt, R.W., Durso, F.T., Goldsmith, T.E., Breen, T.J., Cooke, N.M., Tucker, R.G., & DeMaio, J.C. (1985). *Measuring the structure of expertise.* Las Cruces, NM: Computing Research Laboratory, New Mexico State University.

Shavelson, R. (1974). Methods for examining representations of subject matter structure in students' memory. *Journal of Research in Science Teaching, 11*, 231-249.

Thro, M.P. (1978). *Individual differences among college students in cognitive structure and physics performance*. Paper presented at the annual meeting of the American Educational Research Association, Toronto, Canada.

Whalley, P. (1990). Models of hypertext structure and learning. In D. Jonassen & H. Mandl (Eds.), *Designing hypermedia for learning.* Heidelberg, FRG: Springer-Verlag.

Wittrock, M.C. (1974). Learning as a generative activity. *Educational Psychologist, 11*, 87-95.

Title:

Collaborative Annotation of a Hyperbook on Hypermedia Design

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COLLABORATIVE ANNOTATION OF A HYPERBOOK ON HYPERMEDIA DESIGN

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Introduction

Collaboration in the utilization and construction of hypertext knowledge bases is perhaps the most important characteristic of successful learning-oriented hypermedia applications (Duffy & Jonassen, in press; Jonassen, 1989). Collaboration engages learners in constructive processing of the information rather the mere reception and shallow encoding of information, resulting in more meaningful learning. Learners have been shown to be better able to engage in rational argumentation as a result of collaborative construction of a hypermedia knowledge base (Landow, 1989).

This report describes the results of a process for collaboratively annotating a book about hypertext design and the implications of that process for designing collaborative hypertext environments. The book was the product of a NATO-sponsored Advanced Research Workshop, "Designing Hypertext/Hypermedia for Learning" (Jonassen & Mandl, 1990), which was held in Rottenburg am Neckar, FRG, from July 3-8, 1989. This paper describes the process and results of a collaborative annotation process for inserting internal, conceptual linking in a book on hypermedia design. The results of that process, we believe, have implications for the design of collaborative hypermedia environments.

Context

The idea for the workshop resulted from the burgeoning interest in hypertext during the latter 1980s, combined with the frustrating lack of literature on learning applications for hypertext. There was little evidence in 1988 that hypertext could successfully support learning outcomes. A few projects were investigating hypertext for learning, but few conclusions were available and little if any advice on how to design hypertext for learning applications was available. Could hypertext support learning objectives? What mental processing requirements are unique to learning outcomes, and how do the processing requirements of learning outcomes interact with unique user processing requirements of browsing and constructing hypertext? Should hypertext information bases be restructured to accommodate learning outcomes? Should hypertext user interfaces be manipulated in order to support the task functionality of learning outcomes? Does the hypertext structure reflect the intellectual requirements of learning outcomes? What kinds of learning-oriented hypertext systems were being developed and what kinds of assumptions were these systems making? These and other questions demonstrated the need for this workshop.

The workshop took place over a five day period in a conference center in Rothenburg am Neckar in southwestern Germany. It was hosted by the Deutsches Institut für Fernstudien at the University of Tübingen. The workshop included a number of presentations by various researchers focusing on several themes, including:

Hypermedia and Learning

David Jonassen Scott Grabinger	Problems and Issues in Designing Hypertext/Hypermedia for Learning
John Leggett	Hypertext for Learning
George Landow	Popular Fallacies About Hypertext

Peter Whalley	Models of Hypertext Structure and Learning

Designing the Information Model

Rainer Hammwohner	Macro-Operations for Hypertext Construction
Ray McAleese	Concepts as Hypertext Nodes: The Ability to Learn While Navigating Through Hypertext Nets
Piet Kommers	Graph Computation as an Orientation Device in Extended and Cyclic Hypertext Networks

Designing the User Interface

Jakob Nielsen	Evaluating Hypertext Usability
Patricia Wright	Hypertexts as an Interface for Learners: Some Human Factors
Andrew Dillon	Dsigning the Human-Computer Interface to Hypermedia Applications

Hypermedia and Instruction

Thomas Duffy	Hypermedia and Instruction: Where is the Match?
Terry Mayes	Learning About Learning from Hypertext
Armando Oliveira Duarte Costa Perreira	Psychopedagogic Aspects of Hypermedia Courseware
Wil Verrick, Anja Lkoundi	From Instructional Text to Instructional Hypertext: An Experiment
Cliff McKnight John Richardson Andrew Dillon	Journal Articles as Learning Resource: What Can Hypertext Offer?
Otmar Fölsche	Hypertext/Hypermedia-like Environments and Language Learning
Martin Richart Tom Rüdebusch	Collaboration in Hypermedia Environments

Hypermedia Design Process

Alex Romiszowski	The Hypertext/Hypermedia Solution -- But What Exactly is the Problem?
Gary Marchionini	Evaluating Hypermedia-Based Learning

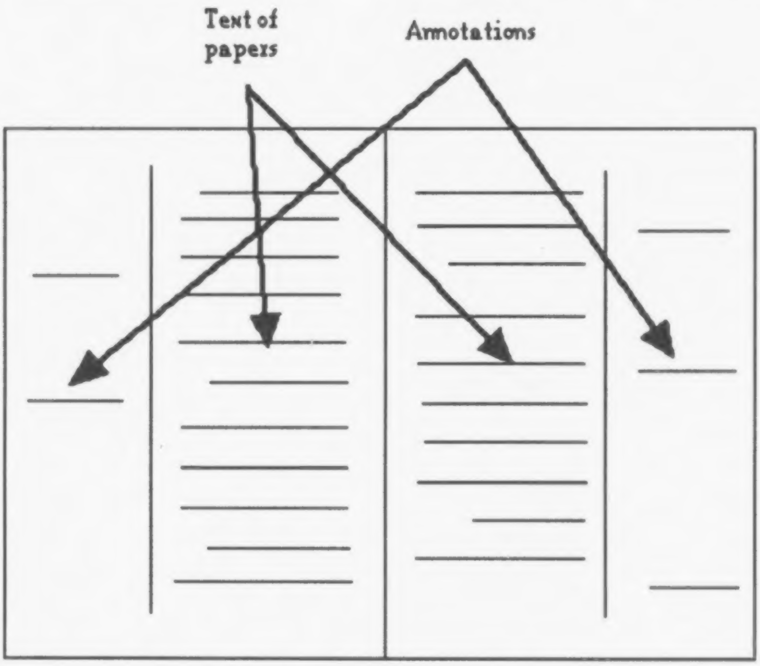
Conceptual Foundations for Designing Hypermedia Systems for Learning

Eric Bruillard Gérard Weidenfeld	Some Examples of Hypertext's Applications

Max Mühlhäuser	Hyperinformation Requirements for an Integrated Authoring/Learning Environment
Norbert Streitz Jörg Hannemann	Elaborating Arguments: Writing, Learning, and in a Hypertext Based Environment for Authoring
Daniel Russell	Alexandria: A Learning Reseources Management Architecture

Problem

The conference consisted of the previous presentations, hardware demonstrations, sharing and browsing of hypertexts, and extensive discussions about all of the above. These latter experiences cannot be effectively shared with the reader of the proceedings. The topic of the conference, hypermedia, represents a dynamic knowledge representation form. It's most dynamic capacity, represented in the presentation by Richartz and Rüdebusch, is the collaborative contribution of different individuals to the knowledge base. In collaborative learning environments, the individuals involved are participants rather than mere respondents. Therefore, we attempted to share the experiences of the conference, especially the dialogue, with the readers of the book while representing the collaborative nature of the conference experience.



Page Layout of Book

Figure 1

Method

Procedure

Following the workshop, we asked each of the contributors to revise their papers to reflect the ideas and discussion shared at the workshop. Each paper needed to make heavier use of headings and to include a list of keywords. Each paper needed to state its assumptions about learning, characteristics of hypertext (one of the conclusions of the workshop was that we should use the more generic term, hypermedia, rather than hypertext), and provide some advice or guidelines for designing hypermedia for learning. These papers were collected and edited. They were re-organized into sections that reflected some of the themes of the workshop.

After receiving all of the edited contributions, the text was initially set using a desktop publishing system. The text of each paper was was set in the larger inside column of each page, leaving the outside column blank.

A copy of the entire book without any annotations was then sent to each participant in the workshop. Each participant was asked to read and annotate the other papers. Participants were given the option of using three types of annotations. The primary type was in the form of qualified annotations (McAleese, Anderson & Duncan, 1982; McAleese & Duncan, 1983). Qualified annotations consisted of predefined relations to be used to connect the text adjacent to the annotation with other text in the book. This type of annotation is similar to using a constrained set of asymmetric (two-way) referential links in hypertext. The qualified annotations used to link ideas in the book included:

example - specific instances of current topic
recommendation - principle for designing hypermedia
background - conceptual/theoretical foundations
explanation - expands or elaborates on current topic
corroboration - supports current topic
illustration - visual illustration of topic
contrast - contradictory interpretation or description
definition - definition of idea or topic
results - relevant research results
parallel - similar interpretation or description
implication - inferential conclusion
methodology - description of relevant research or design methodology

By following these annotated links, the reader may gain additional information (for example, explanation) about the topic that is defined by the link. So, an annotation such as "DJ explanation 4.13" means that DJ (a list of participants and their initials was provided in the introduction to the book) claims that there is an explanation of the idea(s) adjacent to the annotation that can be found on page 4.13. To support this process, it was necessary to provide two forms of pagination in the book, a running, sequential pagination and a chapter and page listing (eg. 4.13). The fomer was a required by the publisher, and the latter form was used to support the linking.

The second type of annotations were unqualified. Participants could provide short comments about the text adjacent to the comment. These were to be used when none of the qualified annotations applied or when there was no other text in the book to which to refer the reader.

The third type of annotation included references to external documents that the author of the text being annotated did not include in the paper. These document references were to be added when the external document has relevance to the discussion. These would enable the reader to follow up on particular discussions more readily. These are similar to symmetric (one way links) in hypertext.

These annotations were received by the primary editor via electronic mail. The electronic mail conference account automatically reflected each submission of annotations to all of the workshop participants via several electronic mail networks. This provided each author with the opportunity to read how other workshop participants reacted to his/her chapter. Each author then had the opportunity to amend their chapter in order to accommodate or react to the pertinent annotations and comments. Limited changes to the document were made to the text, so long as it did not affect pagination. Finally, the annotations, comments, and references were added to the outside column of the book (see Figure 1), which was then printed out in its final form.

In addition to the annotations, other common hypermedia access tools, such as contents lists and keywords for each chapter, are provided.

Following the annotation process, a survey was sent to each of the participants to ascertain what the advantages and difficulties of the process were if they submitted annotations. We were also attempting to ascertain how the process could be facilitated and what benefits accrued.

Rationale

This elaborate and iterative process was undertaken for a number of reasons. First, we hoped that the quality of the ideas and writing would improve if subjected to the scrutiny of peers. Second, we wanted the book to exhibit some of the characteristics of hypermedia. The annotations represent internal links. The references represent external links to other documents. Were this a true hypermedium, the references would consist of links that transport the reader directly to the relevant portion of the referenced document. That is not possible in print without aggregating all of the relevant references in one book. Page and copyright restrictions preclude that. Third, we wanted the book to reflect some of the themes, issues, and opinions discussed but not resolved at the workshop — to engage the reader in some of the dialogues that engaged the participants during the workshop. Finally, we wanted to continue the dialogue begun at the workshop via an electronic mail conference. This represented an opportunity to apply an important technology to facilitating a collaborative process.

Results and Discussion

Over 300 annotations were entered on the network. These were received from only 65% of the workshop participants. The overwhelming majority of the annotations were qualified.

The two most common types of annotation were parallel and contrast, indicating that participants most often agreed and disagreed. Overall though, combining the parallel annotations with the three next most common annotations (corroboration, example, and explanation) yields more than two thirds of the annotations. All of these annotations are supportive of each other, either agreeing with the ideas being presented, helping to explain them, or providing additonal examples which is also explanatory. So rather than using annotation as an opportunity to contrast the diverse opinions presented at the workshop, participants chose to publicly agree with each other.

There was considerable unevenness in the number of annotations provided from various participants. A number of participants refused to participate in the process on principle. Their claim was that the book could not function as hypertext and that to force such a structure onto the book destroyed the continuity and coherence of the book. The most frequent comment receieved via the survey or from informal comments contributed over the e-mail network was that the process was considerably more difficult and time consuming than anticipated at the conference. The annotation process was perceived by those who did so as being much more arduous than they had anticipated. As one participant commented, "Linking is easier said than done." The primary difficulty was the memory load required to holding the contents and approximate location of the contents of a 300 page book in memory and relating it all to the rest of the content. Some participants evolved linking strategies for reducing memory load. They read the book mainly to place links from other articles to their own article and vice versa. The advantages of the linking process related to a focusing of the issues and concerns.

Annotation Type	#	Annotator	#	Date	#	Chapter#	
background	14	Duchastel	5	1/10/90	14	1	36
comment	39	Hammwöhner	7	1/11/90	7	2	6
contrast	72	Jonassen	128	1/12/90	9	3	32
corroboration	45	Duffy/Knuth	20	1/22/90	20	4	26
definition	19	Kommers	14	1/29/90	7	5	12
description	1	Landow	21	2/5/90	15	6	31
example	47	Leggett	59	2/6/90	7	7	24
explanation	54	Marchionini	7	2/7/90	6	8	23
illustration	2	Romiszowski	67	2/9/90	15	9	6
implication	9	Russell	13	2/12/90	59	10	16
methodology	8	Streitz	40	2/14/90	14	11	3
parallel	95	Verrick	16	2/16/90	12	12	27
recommendation	12	Whalley	9	2/19/90	12	13	24
reference	5	Wright	21	2/20/90	129	14	1
results	10			2/23/90	15	15	16
				3/13/90	66	16	8
					17	3	
					18	9	
					19	21	
					20	9	
					21	5	
					22	3	
					24	8	

Table 1
Summary of Annotations

Most of the annotations were submitted in blocks, as authors saved their annotations until they could send them altogether. With only two exceptions, participants sent only one block of annotations.

There was also unevenness in the number of annotations per chapter. The early chapters tended to be annotated more heavily.

Different participants used the linking process to support different types of arguments. That is, there were significant differences in the types of links generated by the different participants. Some generated primarily "contrast" links while others generated "example" and explanation" links. While we had anticipated that the process would provide more of a venue for argumentation, it actually became a medium for mutual support.

Another expressed concern was over the symmetry of the links. The process provided only for one-way links with no return provided. Some particpants expressed concern that such links were not as meanigful as assymmatric links that go both ways.

A number of participants commented on the static nature of the knowledge base. Concern was expressed about the difficulties of annotating a static knowledge base (a print book) and how much more difficult that might become in a dynamic, collaboratively constructed hypermedia knowledge base.

Finally, the syntactic requirements of sharing annotations in an electronic mail environment constrained the sharing process.

Implications for Hypertext

From the annotations and comments that accompanied them, the following recommendations can b made.

- **Since each author is most familiar with his/her own chapter, then annotate the other chapters in the book by providing annotations back to your own chapter or read the text with the thought of annotating your own contribution by relating it to the others.**
- **Depending upon the purpose of the collaborative hypertext, develop a tighter argument structure using fewer annotation types. Collaborative hypertext systems, such as IBIS (Conklin & Begemen, 1987), provide a limited set of options. Users can identifiy issues, add positions to those issues, and then add arguments to the positions. We use such a structure to organize discussion in a doctoral seminar. When individual wnat to add an issue, they are given the choice of declaring advantage, disadvantage, application, problem or limitation nodes when comparing models of instruction.**
- **Provide multiple access points to the hypertext being annotated. Linear documents are more closely scrutnized in the beginning with interest and commitment waning toward the end of the document. Help users to access the document, that is begin processing the document, in different places to ensure even annotations.**
- **Develop some form of cueing help to asist the annotation process. A bookmarking type of cues that can be placed in the hypertext at different locations would reduce the memory load.**
- **Provide the option of creating symmetric or assymmetric links. If two way links are used, ten require that participants define the nature of the link in both directions, since it is bound to differ.**

References

Duffy, T. & Jonassen, D.H. (in press). *The design of constructivistic learning environments.* Hllsdale, NJ: Lawrence Erlbaum.

Jonassen, D.H. (1989) *Designing hypertext/hypermedia for learning*. Paper presented at the annual conference of the Association for the Development of Computer Based Instructional Systems, November 11-14, Washington, DC.

Jonassen, D.H. & Mandl, H. (1990). *Designing hypermedia for learning*. Heidelberg, FRG: Springer-Verlag.

Landow, G. (1989). Popular fallacies about hypertext. In D.H.Jonassen & H. Mandl (Eds.), *Designing hypermedia for learning*. Heidelberg, FRG: Springer-Verlag.

McAleese, R., Anderson, F.D., & Duncan, E.B. (1982). *Qualified citation indexing for educational technology*. Aberdeen, UK: University of Abderdeen, University Teaching Centre.

McAleese, R. & Duncan, E.B. (1983). *Meaning and use of qualifying terms in citation indexing for education*. Aberdeen, UK: University of Aberdeen, University Teaching Centre.

Title:

The Generative Effects of Instructional Organizers with Computer-Based Interactive Video

Author:

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Introduction

In the current information age, society is continually being influenced and reshaped by rapid and pervasive changes in technology. Education has not been immune to these changes, although it has been slow to adapt (Braun, 1990, Dalton, 1989). In particular, the advent of the low priced and accessible microcomputer has placed the power and flexibility of computing into the hands of the individual. A major challenge for instructional designers is to learn how to make effective use of its capabilities to assist people to learn.

An exciting extension of the microcomputer revolution is the interactive computer-based learning system most commonly referred to as Computer-Based Interactive Video (CBIV), a hypermedia system which combines the power of the computer to support student interaction with the richness of the various audio and visual media. The main benefit of hypermedia (Kinzie & Berdel, 1990) is to facilitate learning by "making networks of related information available in a content-appropriate multimedia format (p.62)."

According to Jonassen (1984), the major advantage of CBIV is that it can be both adaptive and interactive. He defines adaptive as "the ability to adapt or adjust the presentation sequence, mode or sign type to meet a variety of instructional requirements..." and interactive to mean "that the program engages the learner to participate in a variety of ways that utilize learner responses..." (p.21).

Hannafin (1989) views interactivity as providing one or more instructional functions from simple procedural control to causing differentiated levels of cognitive processing. These functions of interaction include confirmation of response, learner control of pacing and lesson sequencing, inquiry (glossaries and libraries), navigation, and elaboration, techniques which allow learners to combine known with to-be-learned lesson information.

Learner Disorientation

CBIV, while providing such flexibility, is not without problems. One is the potential for learner disorientation, the loss of one's sense of location or of the structure of the material. Navigation is the most commonly identified user problem in hypermedia (Jonassen, 1989, Kinzie & Berdel, 1990, Rezabek & Ragan, 1989). Learners can easily become lost and frustrated and may give up without acquiring any information from the program.

Another problem is cognitive overload. Jonassen (1989) also notes that the exponentially greater number of learning options available to learners places increased cognitive demands upon learners that they are often unable to fulfil. Tripp and Roby (1990) claim that disorientation leads to the expenditure of more mental effort to maintain a sense of orientation in the program which in turn reduces the mental resources available for learning.

Instructional Design for Hypermedia

How might one then allay such disadvantages of hypermedia while capitalizing on its advantages? In a flexible environment such as hypermedia, self-regulation - skills for self-directed learning - is essential (Kinzie & Berdel, 1990). Systems can be designed to make the exercise of learner control and self-regulation successful and to enhance a learner's continuing motivation. Kinzie & Berdel (1990) suggest the use of such techniques as "motivating overviews" [original emphasis] that encourage users to explore different parts of the program and system maps to locate current position and to move to a desired location.

While Kinzie & Berdel (1990) emphasize self-regulation and motivation, Jonassen (1989) focuses on cognitive structure. In his view, effective browsers of hypermedia must be able to monitor their own comprehension of the information presented and to select appropriate strategies that facilitate integrating and synthesizing information. If the material can be organized to replicate content or expert knowledge structures, then it would better provide the needed anchors for re-structuring the learner's knowledge.

Jonassen (1989) suggests that designers of hypermedia should be concerned with two aspects: the information model presented by the program and the user interface. The former describes how to organize or structure the information. The user interface describes the tools that the user has for accessing and navigating through the system. These include indexes and menus, cross-referencing and hypermaps. A similar notion to system maps, hypermaps provide a graphical view of the program structure, allowing the user to select a node on the hypermap and be taken immediately to that part of the program. The theoretical advantage of using a hypermap (Jonassen, 1989) is that it should enhance the learner's structural knowledge (the knowledge of interrelationships between ideas) of the information in the program.

Instructional Organizers

One approach to enhance structural knowledge is the use of instructional organizers. Tripp & Roby (1990) suggest a traditional strategy, the advance organizer (Ausubel, 1960, 1963). Other related organizational approaches include the structured overview graphic organizer (Barron, 1969) and the pictorial graphic organizer (Hawk, McLeod & Jonassen, 1985), both derivatives of the advance organizer. The pictorial graphic organizer can be either participatory (providing spaces to be filled in by the learner) or final form (spaces already completed when given to the learner). Both structured overviews and pictorial graphic organizers resemble the hypermap and could potentially be used to assist navigation in a CBIV program. All three organizers are designed to relate the material-to-be-learned to the learner's existing cognitive structure to facilitate learning and retention.

Extensive research on the advance organizer has produced a conflicting evidence concerning its effectiveness in facilitating learning. Several reviews have been critical (Barnes & Clawson, 1975, Hartley & Davies, 1976, Macdonald-Ross, 1978, McEneany, 1990), while others have been supportive (Lawton & Wanska, 1977, Mayer, 1979a, 1979b, Luiten, Ames & Ackerson, 1980, Stone, 1984). Overall, advance organizers appear to have a modest effect upon learning and retention (Kenny, 1990). While noting far fewer research results, Kenny also found a modest effect upon learning and retention for structured overview and pictorial graphic organizers.

The few studies of organizers with CBIV-based instruction have mostly focused on the advance organizer. Carnes, Lindbeck & Griffin (1987) reported no significant differences for advance organizers with a computer-based physics tutorial. Krahn & Blanchaer (1986) found a statistically significant difference in favor of advance organizers in a computer-based medical simulation but assessed learning with a very small immediate recall test (six questions). Theory holds that an advance organizer is unlikely to assist immediate recall and should be expected to have its strongest effect on retention (Mayer, 1979a, 1979b). Research results have tended to support this assertion (Luiten, Ames & Ackerson, 1980, Stone, 1984, Kenny, 1990).

Tripp & Roby (1990) report the use of an advance organizer with a Japanese-English hypertext-based lexicon. Half the group using the advance organizer also received a visual metaphor. They speculated that a statistically significant negative effect for the interaction between the two techniques may have negated any effect for the advance organizer.

Kenny, Grabowski, Middlemiss & Van-Neste-Kenny (1991) compared participatory pictorial graphic organizers to identical final form organizers when used with a commercial CBIV program on nursing elderly patients with pulmonary disease. The participatory graphic organizer group outperformed the final form group on a test of immediate recall. The difference was large (1.65 points on an 18-item multiple choice test) but was not statistically significant. However, the final form group obtained a slightly higher (0.18 points) mean score on the retention test (given after one week). As well, surprisingly, the final form group made a considerable gain (1.77 points) from the immediate recall test to the retention test. One would normally expect some forgetting to occur. This difference, however, was not statistically significant. Regardless, the result is consistent with advance organizer theory (Mayer, 1979a, 1979b) and may indicate that the final form graphic organizer affects learning in the same manner as an advance organizer.

Generative Learning

Pictorial and structured overview graphic organizers both appear to be most effective when presented in participatory form, that is, to be filled in or constructed by the learner (Kenny, 1990). Thus, Wittrock's (1974) generative learning hypothesis may provide a stronger basis for explaining the effectiveness of these techniques than does advance organizer theory. Wittrock claims that "it is the learner's interpretation of and processing of the stimuli, not their [the stimuli] nominal characteristics, which is primary" (p.88). In more simple terms, learners must construct their own meaning from teaching (Wittrock, 1985). Doctorow, Wittrock & Marks (1978) indicate that this involves not only generating meaning but overt activities as well; such as, generating associations among words, generating pictures, etc. By way of example, Wittrock (1990, p.347) expresses the view that even reading "involves generative cognitive processes that create meaning by building relations (a) among parts of the text and (b) between the text and what we know, believe and experience." That is, when we read, we generate meaning by relating parts of the text to one another and to our memories and knowledge.

Hypotheses

This study was intended to compare the use of three instructional organizers - the advance organizer (AO), the participatory pictorial graphic organizer (PGO) and the final form pictorial graphic organizer (FGO) - in the design and use of CBIV programs. That is, it attempted to answer the question of which form of instructional organizer (less generative or more generative) would most effectively facilitate learning and retention when used with this form of hypermedia. It was hypothesized that (1) a PGO would be more effective in facilitating immediate recall than would either an AO or the equivalent FGO, (2) a PGO would be more effective in facilitating retention than would the other two techniques and (3) an FGO and an AO would not substantially differ from each other in their effect on immediate recall or retention. A PGO requires the learner to fill in various blanks on the organizer and was considered to be a more generative technique than either its FGO version or an AO. To complete a PGO, the learner must select information from the CBIV program and write it in the appropriate place on the organizer. When using an FGO, the learner is asked only to read and remember the information presented by the organizer. Similarly, the AO presents information at a higher or more abstract level and is also meant to be read and remembered. Thus, it was expected that the PGO would elicit a generative activity from the learner while the FGO and AO would depend on their nominal characteristics for any effect.

Methods

Subjects

The study sample consisted of sixty-two university nursing students and faculty from a university College of Nursing in the northeastern United States. All subjects were female. This sample included three blocks or strata: third year (Juniors) undergraduates (n = 16), fourth year (Seniors) undergraduates (n = 19) and graduates (n = 27). The graduate block was comprised of twenty-one Master's degree students and six faculty members. The posttest data for one graduate, who was given the participatory graphic organizer treatment, was discarded because the subject had disregarded treatment instructions and took copious notes on both the front and back of the form. This left a total sample of sixty-one individuals.

Materials

An American Journal of Nursing CBIV program, The Nursing Care of Elderly Patients with Acute Cardiac Disorders was used in this study. This program presents two case studies each of which follow the progress of an elderly male patient from admission to hospital to discharge. One patient is admitted with a heart attack while the other is treated for congestive heart failure. The content of the program consists of specialized knowledge and skills in acute cardiac care such as the recognition of age-related changes in cardiac function, cardiac pathophysiology, knowledge of cardiac drugs and the reading of electrocardiogram (EKG) rhythms. The case studies consist of several video sequences of patient - nurse interactions, including decisions about how to treat the patient's condition and nursing responses to an emergency situation resulting from treatment.

The program uses a structured discovery approach in which the learner is presented with a video sequence followed by a decision point. At each point, the learner must make appropriate nursing assessment or intervention decisions in order to proceed. These decisions are rated on a scale ranging from +3 to -3. Those judged by the program harmful to the patient are scored -2 or -3 and result in immediate feedback accompanied by a request to try again. Appropriate or neutral decisions are accepted without immediate feedback. The learner cannot advance until sufficient appropriate decisions have been made. The prior video sequence is then replayed and accompanied by voice-over analysis by an experienced nurse.

Independent variables

The primary independent variables were the three instructional treatments: the PGO (considered the most generative), the FGO and an expository AO. The three organizers used in the study were developed by two subject matter experts (on adult medical-surgical and critical care nursing) and the author, whose expertise is in instructional design.

The graphic organizers were constructed according to Hawk, McLeod and Jonassen (1985). They were identical except that the FGO was completed while various blanks were left to complete in the PGO. They were designed to provide a combined chronological and comparison - contrast structure, that is, they followed the admission-to-hospital through treatment and discharge sequence of the program and provided side-by-side comparison of the stages for each case study.

The AO was constructed in expository form according to the prescriptions of Ausubel (1963, 1978) and Mayer (1979a). The content of the AO consisted of a discussion of clinical decision-making and the nursing process. This included an overview and a brief discussion of the five steps of the nursing process: assessment, diagnosis, planning, intervention and evaluation. The organizer also related the nursing process to collaborative problems which are solved in conjunction with medical personnel. All subjects would have studied this process in past and had varying degrees of familiarity with the material.

Dependent Variables

There were two dependent variables in this study: immediate recall and retention. Immediate recall was operationalized as a test of learning from the CBIV program given immediately after completion of the program and retention as a similar measure of learning given one week later. Both were measured by two, equivalent form, 24-question, multiple choice, posttests developed by the producers of the CBIV program. The posttests were criterion-referenced and nearly identical in format and question type. In most cases they differed only in terms of situational information such as patient assessment data. The test questions were developed on the basis of program objectives and follow nursing care scenarios resembling, but not identical to, the CBIV program itself (Rizzolo, personal communication). All questions tested nursing assessments and interventions for which the program was designed to provide practice.

Internal consistency reliability (Kuder-Richardson Formula 21) was 0.66 for Form A and 0.64 for Form B. The stability and equivalence reliability estimate was 0.59. Popham (1981) indicates that this yields the lowest estimate of test reliability since two factors - time delay and differences between the test forms - operate to reduce consistency of measurement. Estimates of 0.70 and lower may be considered acceptable for equivalence and stability.

Procedures

Subjects were randomly assigned to the three treatment groups - PGO, FGO or AO - by block (strata). All subjects were asked to read their organizer immediately prior to doing the CBIV program. The purpose of the organizer was explained at that time. Those in the PGO treatment group were also asked to fill in the blanks in the organizer either during or immediately after the CBIV program. The subjects were given complete freedom to proceed through the program as they wished although they were requested to attempt both case studies. They were, however, asked not to take notes except where required by the PGO treatment. This was done to counteract note-taking as a possible confounding factor, a problem which occurred in the previous study (Kenny, Grabowski, Middlemiss & Van-Neste-Kenny, 1991).

Students completed the first posttest (immediate recall) immediately after finishing the CBIV program and the second (retention) posttest one week later. They did not have access to the program in between testings.

Experimental Design

This study used a three by three by two factorial design with one repeated measure, or a split plot factorial (SPF) design (Kirk, 1982). The design factors for this study were the three treatment groups, the three blocks (Junior, Senior, Graduate), and the order of presentation of form of posttest. All subjects were randomly assigned to either Form A or Form B of the posttest for the test of immediate recall and given the other form for the retention test. This counterbalancing was carried out in order to compensate for any bias which might have resulted from differences in the two versions of the test. The criterion-referenced posttests represented the repeated measures factor.

The hypotheses were analyzed using planned contrasts. This was accomplished in two steps. First, a 3x3x2 MANOVA with one repeated measure was conducted to provide a pooled Mean Square Error term for the calculation of the planned contrasts and to provide a test of any main effects for the blocking and counterbalancing factors and their interactions with the main treatment effect.

Second, examination of the hypotheses reveals that a test of all pairwise comparisons was required. Consequently, the use of Tukey HSD contrasts was appropriate and, in this situation, more sensitive than the use of Dunn's procedure. Therefore, all six hypotheses were tested using the Tukey HSD procedure at $\alpha \leq 0.10$ level.

Convention holds that alpha is generally set at ≤ 0.05 and the selection of the 0.10 level may be considered liberal. Cohen (1990), however, labels the former a "convenient reference point along the possibility-probability continuum" (p.1311) and claims there is no ontological basis for the dichotomous, yes-no decision of prevailing practice. He calls for the use of "more tolerant" 80% confidence levels in social science research (p. 1310) and the reporting of one or more effect sizes as the primary product of research inquiry. The choice of $\alpha \leq 0.10$ represents a compromise between convention and Cohen's position which allows for increased power and yet provides a reasonably stringent test of statistical significance.

Cohen (1988, 1990) also recommends power analysis. The Stone (1984) study was the more recent of two advance organizer meta-analyses and more consistent with advance organizer theory. The average effect size of 0.66 for retention from this study represents an intermediate estimate for the effect of instructional organizers on retention (Kenny, 1990) and was used in this analysis. For E.S. = 0.66, n = 20 (for each treatment group) and $\alpha \leq 0.10$, power ($1-\beta$) is 0.78 and β error is 0.22. Cohen (1988) recommends a minimum standard for $1-\beta$ of 0.80. Therefore, based on the Stone meta-analysis, this study is slightly underpowered.

Exploratory Data

In addition to the posttests used to measure learning, the subjects completed a one page Program Use Survey which provided a self report of their use of such program options as the replay feature, the library and the glossary. The time each subject spent on the program was also measured and correlated, using Pearson r product moment coefficients, with posttest scores. Finally, every third subject from each treatment group and block (n = 18) was asked to participate in a semi-structured interview with the author after completing the second posttest. These interviews were intended to elicit a more detailed reflection of the participants' use of the CBIV program and of the instructional organizers.

Results

Results for descriptive statistical data are displayed in Table 1 and for the MANOVA in Table 2. Hypothesis 1 held that the use of a PGO would result in a higher mean score on a measure of immediate recall (Posttest 1) than would the use of either an FGO or an AO. This hypothesis was not supported. The PGO treatment resulted in a lower mean score on the first posttest (18.05) than did the AO treatment (18.857).

The difference was not statistically significant $[|0.807| < q_{.90}\ (3, 120) = 1.77]$.

The PGO treatment also resulted in a substantially lower mean score on the first posttest (18.05) than did the FGO treatment (20.9). Further, the difference was statistically significant at the $p \le$ 0.01 level. $[|2.85| > q_{.99}\ (3, 60) = 2.622]$.

Table 1

Descriptive Statistics

		Posttest 1		Posttest 2	
	N	M	SD	M	SD
PGO	20	18.05	3.09	16.70	3.66
FGO	20	20.90	2.77	19.40	3.79
AO	21	18.86	2.99	18.52	3.30

Table 2

Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	df	SS	MS	F	p
Treatment	2	94.08	47.04	4.21	0.022*
Order	1	30.33	30.33	2.71	0.107
Treatment*Order	2	19.56	9.78	0.87	0.424
Block	2	318.63	159.32	14.25	0.0001**
Treatment*Block	4	76.24	19.06	1.70	0.167
Order*Block	2	23.54	11.77	1.05	0.358
Treatment*Order *Block	4	36.00	9.00	0.80	0.529
Error	43	480.88	11.18		

* $p \le .05$
** $p \le .01$

Hypothesis 2 stated that the use of a PGO would result in a higher mean score on a measure of retention than would the use of either an AO or an FGO. Once again, the hypothesis was not supported as the PGO treatment resulted in a lower mean score on the second posttest (16.7) than did the AO treatment (18.52). The difference was statistically significant at the $p \le$ 0.10 level. $[|1.84| < q_{.90}\ (3, 60) = 1.790]$. The PGO treatment also resulted in a substantially lower mean score on the second posttest (16.7) than did the FGO treatment (19.4). This difference was statistically significant at the $p \leq 0.01$ level. [$|2.70| < q_{.99}$ (3, 60) = 2.622].

The third hypothesis asserted that the use of an FGO would result in no greater effect on immediate recall or retention than would the use of an AO. This hypothesis was not completely supported. The FGO treatment resulted in a considerably higher mean score on the first posttest (20.9) than did the AO treatment (18.857). This difference was statistically significant at the $p \leq 0.05$ level. [$|2.043| < q_{.95}$ (3, 86) = 2.0367]. However, while the FGO treatment also resulted in a higher mean score on the second posttest (19.4) than did the AO treatment (18.524), the difference was not statistically significant [$|0.877| < q_{.90}$ (3, 120) = 1.77].

Analysis of Exploratory Data

Crosstabulations of the comparison between treatments by survey subquestion displayed no patterns indicating a differential use of the CBIV program which might explain the difference in posttest means among treatments. Further, analysis of variance of the mean survey question scores showed no statistically significant difference between the three organizers.

Nor was there an apparent difference among the three treatment groups in the amount of time taken doing the program. Pearson r correlation coefficients are reported in Table 3. None were statistically significant.

Table 3

Pearson r Correlation: Time * Posttest Scores

Treatment	Time r	Time p
AO Immediate	-0.322	0.154
AO Retention	-0.045	0.845
FGO Immediate	0.187	0.431
FGO Retention	-0.240	0.307
PGO Immediate	-0.122	0.608
PGO Retention	-0.153	0.520

Also, with the exception of the correlation between the FGO posttest 1 and time taken, the relationship was always negative. As well, more detailed analysis of the scatterplot for this relationship and of the Program Use Survey indicates an outlier representing an individual who did not complete either case study. Elimination of her scores changes the correlation between time taken and the FGO posttest 1 scores to -0.153 and while the coefficient for posttest 2 drops to -0.27. It appears that those who took more time doing the program tended on average to score lower on the posttests.

Finally, analysis of the interview data revealed a number of trends. Perhaps the most striking trend was that the guided discovery approach, which required the learner to make nursing assessment and intervention choices and rated them on their decisions, tended to be distracting and disorienting for most subjects. Subjects had problems with the way these choices were rated, on the amount of information provided in response to these answers and the manner in which it was given.

The interview data also revealed that the study was able to provide conditions under which instructional organizers, particularly AO's might be expected to be effective. Most participants reported the lesson material to be unfamiliar and moderately difficult. The effect of the different organizers on the subjects' encoding process is less clear. Most found the AO treatment irrelevant. The FGO, on the other hand, was found to be a useful orientation tool by many study participants. It proved particularly helpful as a guide to assessment and intervention decisions. That the PGO treatment tended to influence encoding is less clear from interview responses. Some reported its usefulness while others found it an interference. Several had wished to alter its use to suit their own learning approach.

Finally, the question of whether or not the restriction on note-taking was a confounding factor is also unclear. Slightly more than half those interviewed indicated that they found this an interference while the others stated it was not a problem. Those who found the restriction an interference wanted the notes to allow them to review, either for future testing or for use of the information on the job. Those who did not indicated that they would not have taken notes regardless or that they were poor note-takers and did not tend to make good use of their notes.

Discussion

The first and second hypotheses predicted that learners receiving a PGO - operationalized as the more generative treatment in this study - would outperform, on average, those who received either an AO or the equivalent FGO on tests of both immediate recall and retention. Confirmation of these hypotheses would provide evidence that Wittrock's (1974) generative learning hypothesis could be applied to the use of instructional organizers with CBIV. However, analysis of the results indicated no significant effect in favor of the PGO treatment on the mean scores of either posttest. In fact, the PGO treatment group had the lowest mean score in every comparison. The results of this study, then, provide no evidence to support the application of the generative learning hypothesis as operationalized as a PGO. Unquestionably, the filled-in version of the same organizer was the most effective technique.

The third hypothesis predicted no difference between the FGO and AO treatments. While not expected, evidence in favor of the AO treatment might have provided support for advance organizer theory and for the effectiveness of this technique when used with CBIV. The AO fell somewhere in between the other two techniques. As predicted by theory (Mayer, 1979a, 1979b), the AO in this study was not effective in aiding immediate recall. However, neither was it the most effective in assisting retention. While significantly more effective than the PGO treatment, it was less effective (though not statistically significantly so) than the FGO in aiding retention.

These results raise two issues. First, why would the same organizer be much less effective when the learner had to seek answers in the CBIV program to complete it than when the information was provided? Second, why was the AO not more effective?

Exploratory quantitative analysis indicated no substantive differences between treatment groups which might answer these questions. There was no evidence of the differential use of the program features nor of any effect on time on task for any treatment group. As well, examination of the organizers revealed that extraneous note-taking, a problem in the previous study (Kenny, Grabowski, Middlemiss & Van-Neste-Kenny, 1991), was controlled in this experiment.

Was the generative activity truly generative?

The most likely explanation for the ineffectiveness of the PGO was that, as operationalized in this study, it did not constitute a generative activity. As in the previous study (Kenny, Grabowski, Middlemiss & Van-Neste-Kenny, 1991), completion of the PGO remained a problem. Twenty-five percent (five of twenty) of the PGO group left five or more blanks incomplete and ten percent left more than ten spaces incomplete. The PGO's were also scored to determine if they were being completed correctly. The average score was 21.6 of a possible 38, indicating that the subjects completing the PGO were having difficulty determining what went in the blanks. From these two studies, it appears that learners may need further assistance in using this technique, in the form of training, more clear categories on the organizer or some form of feedback in order to make use of this technique. Indeed, Hawk, McLeod & Jonassen (1985) do recommend that the instructor review the PGO periodically with the students and verify its correct completion at the end of the unit. This was not possible in this study and would have added a practice factor as an alternative explanation to the expected generative effect. However, it is feasible in CBIV to provide the PGO on screen (rather than on paper) and to have it corrected electronically.

The PGO may also have constituted an additional activity in an already generative situation and may have actually contributed to, rather than counteracting, cognitive overload. The interview data indicate that learners had considerable difficulty with the structured discovery approach. It is this aspect of the program design which appears to provide the strongest explanation of the superiority of the FGO. The learners were repeatedly faced with making nursing assessment and intervention decisions. They were unable to proceed unless their decisions were appropriate. To make the correct decisions, they needed information and some of this was contained in the blanks on the FGO (but left out to be filled in by the learner in the case of the PGO).

Interview comments about the FGO almost all focused on its usefulness in "getting through" the assessment and intervention segments. They saw it as a form of cheat sheet. The FGO, then, appears to have reduced learner confusion and disorientation by making it easier to proceed. It reduced cognitive overload by directly indicating some assessment and intervention choices and providing clues to others. The subjects in this group strongly outperformed those in the other treatment groups on both posttests. Thus, it seems reasonable to suggest that the FGO may have allowed those subjects receiving this treatment to concentrate more fully on learning the material while the subjects in the other two groups had to expend more effort merely getting through the program.

The AO clearly did not contain the information needed to proceed through these segments. It was not meant to. Its purpose was to prepare the learner's cognitive structure to receive the information in the program and, thus, to aid retention. The PGO, would only have contained the needed information for the assessment and intervention decisions if the subjects in that group had been filling out the form correctly as they proceeded. This assumes that they were able to determine what went into the spaces provided before reaching assessment or intervention selection screens. It is likely that the participants were not able to do so. The details were provided after the assessment and intervention choices by means of a review of the sequence and analysis by an expert nurse. Like the AO treatment group, the only information that they had available was what they remembered.

The members of both the PGO and AO treatment groups were faced with confusion and, occasionally, frustration created by this specific program feature and their particular organizer appeared to be no help. To make matters worse, while those in the PGO group were coping with this difficult process, their organizer was asking them to carry out an additional task. It may have produced cognitive overload by asking the learners to expend more mental effort on this additional activity when they were already engaged in a difficult task. Consequently, it is doubtful that they were able to sufficiently focus on the PGO and to generate their own meaning from it. This may explain the relatively low scores (an average of 21.6 out of 38) on the organizer.

Was the advance organizer used according to theory?

The second issue pertained to the apparent ineffectiveness of the AO. While the AO in this study was more effective than the PGO, it was consistently less effective than the FGO. A frequent criticism of advance organizers is that it is not clear how to construct them (e.g. Barnes & Clawson, 1975, Hartley & Davies, 1976). This is disputed by Ausubel (1978) and Mayer (1979a) who stressed that these reviews were not sufficiently sensitive to theory. Thus, for example, an AO must be presented at a higher, more abstract level and in advance of the material-to-be-learned. It can be expected to facilitate retention rather than immediate recall and to be effective only if the material-to-be-learned is difficult, unfamiliar to the learner or disorganized. Is it possible that the AO used in this study was constructed poorly or used in a instructional situation in which it could not be expected to facilitate learning?

The specifications of Ausubel (1963, 1978) and Mayer (1979a) were followed closely in constructing the AO used in this study. The organizer discussed two higher level (more abstract) topics, the nursing process and collaborative problem-solving. Both processes were carefully adhered to in the nursing care portrayed throughout the program and provided the basic sequence of each case study. In neither case study, however, were the nursing process nor collaborative problem-solving specifically discussed, that is, the organizer clearly is presented at a higher, more abstract level than the CBIV program material and contains no specific content (the actual cardiac material) from the CBIV program. It was presented before the subjects did the CBIV program.

As well, the subjects who participated in this study had neither been trained nor had worked in the cardiac specialty. The interview data confirmed that they were generally unfamiliar with the program material. They also rated the material as moderately difficult. Mayer (1979a) also stipulated that an AO, to be effective, must be capable of generating relationships in the material-to-be-learned and of influencing the learner's encoding process. The first point is answered in the construction of the various organizers. All have clear structures and were judged capable of generating such relationships.

The second point, while also a matter of judgment by the instructor or instructional designer, can only be truly decided after the fact. The analysis of the posttest mean scores appears to indicate that the PGO had little facilitating effect (and may have impeded encoding) while the FGO had the strongest influence. The effect of the AO, which fell somewhere in the middle of the two versions of the graphic organizer, is difficult to determine from this evidence. The interview responses, however, cast some doubt about whether it did. The AO taught (or reviewed) the theory of nursing process. Two graduate students in this treatment group noted that the organizer stimulated them to think about this process while doing the program. One junior failed to see the use of the AO but remembered its content as familiar which may indicate it had a subconscious effect. The rest saw no connection between the program and organizer material. For them, any influence on encoding, therefore, would have had to be quite subtle.

In summary, perhaps the best explanation for the effectiveness of the FGO treatment stems from the structured discovery approach of the CBIV program design which appeared to cause considerable confusion and disorientation for the study's participants. The FGO contained specific information which may have allowed the subjects in that treatment group to more successfully navigate these sequences and to concentrate more fully on learning the content of the program. The AO and the yet-to-be-completed PGO did not contain such information and likely did not provide any assistance. The PGO may have even contributed to cognitive overload by presenting an extra demand upon the learners' mental resources at a time when they were already faced with a difficult task and effectively interfered with their learning rather than assisting it. These results demonstrate that instructional design choices about which such techniques to include with instruction provided by CBIV depend on context. Rather than depending on one most effective technique or instructional theory for all circumstances, instructional designers may have to take into account the specific design attributes of the program in question and choose accordingly.

Recommendations for Further Research

It was assumed for the purposes of this study that participatory pictorial graphic organizers (PGO) were a form of generative activity and would be more effective in assisting students to learn and retain information from a CBIV program than either its FGO version or an AO, forms which are dependent on their nominal characteristics for any effect on learning. This prediction was not supported by the results. The participatory form was the least effective. One explanation is that the PGO was not a generative activity as presumed. To test this hypothesis, further research could be conducted comparing the PGO to other instructional techniques demonstrated, or postulated, to be generative, such as pattern notes (Jonassen, 1984, Fields, 1982) and concept maps (Novak & Gowan, 1984).

Second, the results of this study supported the use of the FGO, at least with instruction presented in CBIV of a similar design to the Cardiac program. A further test of the effectiveness of this technique could be carried by comparing its use to that of hypermaps (Jonassen, 1989) or to an epitome used in instruction developed on the basis of Elaboration Theory (Reigeluth and Stern, 1983) as suggested by Rezabek and Ragan (1989). Further, this contrast could be conducted with hypermedia of varying structure, such as a CBIV program developed using Elaboration Theory, one organized in modules like that used in this study or even a program featuring unstructured hypertext.

Jonassen (1989) also suggested that the less structured the hypertext is, the less likely are users to integrate what they have learned into their own knowledge structures. He proposed that if the material can be organized to replicate content or expert knowledge structures, then it would better provide the needed anchors for re-structuring the learner's knowledge. In fact, in this study, the AO and the PGO were advanced as possible methods to provide such anchors by reflecting the higher level content structure of the material-to-be-learned. The assumption was that learners might lose track of any such structure provided by the program when using various program options. However, in this study, the subjects followed the program structure quite carefully. The comparison of the use of the FGO to other techniques such as hypermaps in both structured and unstructured hypertext versions of the same material might shed further light on how these techniques facilitate learning.

Third, research on the use of diagrams in instruction (Winn & Holliday, 1982) has indicated the usefulness of including small pictures to teach concept identification. The graphic organizers in this study make use of a number of such pictures. For instance, a cartoon depiction of a heart with an injured area is used to indicate that one case study deals with a heart attack while a similar cartoon represents congestive heart failure. Similarly, a drawing of a stethoscope is used to indicate sections of the organizer pertaining to nursing assessments and a sketch of a magnifying glass to denote sections focusing on observations. What is the role of such pictures in the pictorial graphic organizer? Do they add something or does the organizer depend on its diagrammatic elements such as the placement of headings and boxes for its effect? One relatively simple study would involve the comparison of the use of the FGO with pictures to its equivalent form with the pictures removed.

Also, Wittrock and Alesandrini (1990) sought to determine how learners use their analytic processing ability (ability to abstract a common dimension across stimuli) and holistic processing ability (ability to construct a whole from information about its parts) differently under varying conditions. In the previous study (Kenny, Grabowski, Middlemiss & Van Neste-Kenny, 1991), it was hypothesized that the graphic organizer would stimulate both analytic and holistic processing. While no relationship was found, the study also used a small sample size. The interaction of diagrammatic techniques such as the graphic organizer with individual ability and preference needs further investigation. For instance, as Jonassen (1989) stressed, techniques such as hypermaps depend on spatial skills that a learner may lack and should be used with caution. Is this true? What spatial skills are needed to effectively process a hypermap or a graphic organizer? How would a learner's holistic processing ability (ability to construct a whole from information about its parts) relate to these skills?

Finally, the note-taking requirement of the PGO raises the question of structured versus unstructured note-taking. Do some students take good notes and others not? Would students benefit from training in note-taking? Are structured note-taking techniques a generative activity or do they interfere with the learner's generation of meaning by being too constraining? There are clearly a number of research questions about note-taking suggested by this study which could be investigated. An obvious extension of this study would be the comparison of constraining learners to the structure provided (as was done with the PGO treatment) to allowing them to use the structure as a guide which they could modify as they see fit. And last, it would be informative to compare a structured note-taking format such as the PGO to other note-taking techniques such as pattern noting (Jonassen, 1984, Fields, 1982).

References

American Journal of Nursing Company. (1988). Nursing care of the elderly patient with chronic obstructive pulmonary disease [Computer program]. New York, NY.

Ausubel, D.P. (1960). The use of advance organizers in the learning and retention of meaningful verbal material. Journal of Educational Psychology, 51 (5), 267-272.

Ausubel, D.P. (1963). The psychology of meaningful verbal learning. New York:Grune and Stratton.

Ausubel, D.P. (1978). In defense of advance organizers: A reply to the critics. Review of Educational Research, 48(2), 251-257.

Barnes, B.R. & Clawson, E.U. (1975). Do advance organizers facilitate learning? Recommendations for further research based on an analysis of 32 studies. Review of Educational Research, 45(4), 637-659.

Barron, R.F. (1969). The use of vocabulary as an advance organizer. In H. Herber & P.L. Sanders (Eds.) Research in Reading in the Content Areas: First Year Report. Syracuse, NY: Syracuse Reading and Language Arts Center.

Braun, L. (1990). Vision Test Final Report: Recommendations for American Educational Decision Makers. Eugene, OR: The International Society for Technology in Education.

Carnes, E.R., Lindbeck, J.S. & Griffin, C.F. (1987). Effects of group size and advance organizers on learning parameters when using computer tutorials in kinematics. Journal of Research in Science Teaching, 24(9), 781-789.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Erlbaum Associates.

Cohen, J. (1990). Things I have learned (so far). American Psychologist, 45(12), 1304-1312.

Dalton, D.W. (1989). Computers in schools: A diffusion/adoption perspective. Educational Technology, 29(11), 20 - 27.

Doctorow, M., Wittrock, M.C., & Marks, C.B. (1978). Generative processes in reading comprehension. Journal of Educational Psychology, 7(2), 109-118.

Fields, A. (1982). Getting started: Pattern notes and perspectives. In David H. Jonassen (Ed.), The Technology of Text: Principles for Structuring, Designing, and Displaying Text. Englewood Cliffs, NJ: Educational Technology Publications, Inc.

Glaser, R. (1971). A criterion-referenced test. In W. James Popham (Ed.), Criterion-referenced measurement: An introduction. Englewood Cliffs, NJ: Educational Technology Publications.

Hannafin, M.J. (1989). Interaction strategies and emerging instructional technologies. Canadian Journal of Educational Communication, 18(3), 167-179.

Hartley, J. & Davies, I.K. (1976). Preinstructional strategies: The role of pretests, behavioral objectives, overviews and advance organizers. Review of Educational Research, 46(2), 239-265.

Hawk, P.P., McLeod, N.P., & Jonassen, D.H. (1985). Graphic organizers in texts, courseware, and supplemental materials. In David H. Jonassen (Ed.) The Technology of Text: Volume Two. Englewood Cliffs, NJ: Educational Technology Publications, Inc.

Jonassen, D.H. (1984). The generic disc: Realizing the potential of adaptive, interactive videodiscs. Educational Technology, 24(7), 21-24.

Jonassen, D.H. (1989). Hypertext/hypermedia. Englewood Cliffs, NJ: Educational Technology Publications, Inc.

Kenny, R.F. (1990). Are instructional organizers effective when used in computer-based interactive video? In D.W. Dalton (Ed.), Proceedings of the Thirty Second Annual International Conference of the Association for the Development of Computer-Based Instructional Systems (pp. 294-304). San Diego, CA: Association for the Development of Computer-Based Instructional Systems.

Kenny, R.F., Grabowski, B.L., Middlemiss, M. & Van Neste-Kenny (1991, November). The generative effects of graphic organizers with computer-based interactive video by global and analytic thinkers. Paper presented at the annual meeting of the Association for the Development of Computer-Based Instructional Systems. St. Louis, Missouri.

Kinzie, M.B. & Berdel, R.L. (1990). Design and use of hypermedia systems. Educational Technology: Research and Development, 38(3), 61-68.

Kirk, R.E. (1982). Experimental design: Procedures for the behavioral sciences (2nd ed.). Belmont, CA: Brooks/Cole Publishing Company.

Krahn, C.G. & Blanchaer, M.C. (1986). Using an advance organizer to improve knowledge application by medical students in computer-based clinical simulations. Journal of Computer-Based Instruction, 13(3), 71-74.

Lawton, J.T. & Wanska, S.K. Advance organizers as a teaching strategy: a reply to Barnes and Clawson. Review of Educational Research, 47(1), 233-244.

Luiten, J., Ames, W. & Ackerson, G. (1980). A meta-analysis of the effects of advance organizers on learning and retention. American Educational Research Journal, 17(2), 211-218.

Macdonald-Ross, M. (1978). Language in texts. Review of Research in Education, 6, 229 -275.

Mayer, R.E. (1979a). Can advance organizers influence meaningful learning? Review of Educational Research, 49(2), 371-383.

Mayer, R.E. (1979b). Twenty years of research on advance organizers: assimilation theory is still the best predictor of effects. Instructional Science, 8, 133-167.

McEneany, J.E. (1990). Do advance organizers facilitate learning? A review of subsumption theory. Journal of Research and Development in Education, 23(2), 89-96.

Novak, J.D. & Gowan, D.B. (1984). Learning how to learn. New York: Cambridge University Press.

Popham, W.J. (1981). Modern Educational Measurement. Englewood Cliffs, NJ: Prentice-Hall.

Reigeluth, C.M. & Stern, F.S. (1983). The elaboration theory of instruction. In C.M. Reigeluth (Ed.), Instructional-design theories and models: An overview of their current status. Hillsdale, NJ: Lawrence Erlbaum Associates.

Rezabek, R.H. & Ragan, T.J. (1989, February). Elaborated resources: An instructional design strategy for hypermedia. Paper presented at the annual meeting of the Association for Educational Communication and Technology. Dallas, Texas. (ERIC Document Reproduction Service No. ED 300 787).

Stone, C.L. (1984). A Meta-analysis of advance organizer studies. Journal of Experimental Education, 51(4), 194-199.

Tripp, S.D. & Roby, W. (1990). Orientation and disorientation in a hypertext lexicon. Journal of Computer-Based Instruction, 17(4), 120-124.

Winn, W. & Holliday, W. (1982). Design principles for diagrams and charts. In David H. Jonassen (Ed.), The Technology of Text: Principles for Structuring, Designing, and Displaying Text. Englewood Cliffs, NJ: Educational Technology Publications, Inc.

Wittrock, M.C. (1974). Learning as a generative process. Educational Psychologist, 11(2), 87-95.

Wittrock, M.C. (1985). Teaching learners generative strategies for enhancing reading comprehension. Theory into Practice, 24(2), 122-126.

Wittrock, M.C. (1990). Generative processes of Comprehension. Educational Psychologist, 24(4), 345-376.

Wittrock, M.C. & Alesandrini,K. (1990). Generation of summaries and analogies and analytic and holistic abilities. American Educational Research Journal, 27(3), 489-502

Title:

Modeling the School System Adoption Process for Library Networking

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The successful inclusion of school library media centers in fully articulated networks involves considerable planning and organization for technological change. No model to assist school systems in the decision-adoption process previously existed in the literature. In this study a preliminary model of the stages of school system participation in library networks was developed with the major activities for each stage identified. The model follows the stages in the innovation adoption and diffusion literature and is constructed from the study of the literature, observation, and informal interviews. The model is composed of four primary aspects: technological support, financial support, human support, and activities and applications. Within each aspect, anticipated events in each of the three stages of participation in a network are identified.

The population for the study included school systems in one or more of three types of networks: OCLC vendors, state regional multitype networks, and state-wide school networks. A random sample of 674 school systems in 17 states with 3,613 school systems was drawn. A questionnaire based on the preliminary stage model was mailed to district level persons responsible for school media programs, school contact persons for the library network, superintendents, or building school library media specialists. Usable responses were received from 362 school systems in 13 states.

Descriptive statistics were used to provide a profile of the respondents by state, type of network, position of respondent, size of school district, school type, and level of involvement. Profiles by the reported level of involvement in a network were done by state and size of the school district. Chi-square and gamma coefficient tests were performed on each variable in the questionnaire in relation to the level of involvement reported by the respondent. Sixteen of the nineteen variables in the model tested significant. When analyzed by type of network (school vs OCLC) 11 events tested as significant; however, when analyzed by position of the respondent, size of the school system, and years in a network few events tested significantly different under the additional parameters. As do other models, this one provides a guide for users to assess their own progress in adoption of an innovation and to plan for positive action.

SCHOOL NETWORKING INNOVATION MODEL

	Phase I	Phase II	Phase III
	TECHNOLOGICAL SUPPORT		
* Microcomputers	Some evidence of use of computers	Periodic use of computers	Regular use of computers
* Telecommunications	No modem in school	No modem in media center	Modem in media center
* Telephone	No telephone in media center	Efforts to obtain telephone	Telephone in media center
	FINANCIAL SUPPORT		
Interlibrary Loan	None budgeted for ILL	Requests for ILL budget	ILL costs in budget
Network dues	None budgeted for dues	Special funds used for dues	Network fees and dues in budget
* Network activities	None for networking activities	Special funds for network activities	Communication expenses in budget

HUMAN SUPPORT

* Meetings	Informal meetings	Formal meetings	Organization formed
Inter-library loan	Casual requests for ILL	Centralized requests for ILL	Individual requests for ILL
* Policies	Informal agreements	Preliminary policies being formed	Written policies
* External resources	Awareness of external resources	Investigation of external resources	Use of external resources
* Staff	No additions	Requests for staff made	Staff added
* System level support	Little support Formal meetings	Media services position at system level	Consulting services by network

ACTIVITIES AND APPLICATIONS

* Serials	Exchange lists of serials	Union list of serials	Union catalog of serials
* Special collections	Exchange lists of special collections	Union list of special collections	Union catalog of special collections
* Collection development	Awareness of cooperative collection development	Exploration of cooperative collection development	Cooperative collection development

* Cooperative technical services	Awareness of cooperative technical services	Exploration of cooperative technical services	Technical services cooperation
* Delivery methods	Awareness of material delivery methods	Investigation of material delivery methods	Use of material delivery system
Teach use of external resources	Awareness of external resources in reference skills instruction	Use of union lists taught in reference skills instruction	Regular use of external resources by students

* significant for $p<.05$

(Kester, 1990, 72-74, 124)

The model serves as a guide to understanding the process and also provides a pattern for other school systems to follow as they explore resource sharing. Events in each phase will differ depending upon local support, but the research supports the general activities. Movement will not be in distinct steps but will be a gradual transition as schools move into a shared resources environment.

PHASE ONE

TECHNOLOGICAL SUPPORT. In the area of technology, the media coordinator is exploring the use of a microcomputer. He or she may need to go to the computer lab to use a machine, but at least one application package is being used for library management. Examples might be a graphics production program such as *Print Shop* or a word processing program for letter writing. There is no telephone in the media center. A call other libraries or vendors, necessitates leaving the media center and walking to the office or teacher's phone.

FINANCIAL SUPPORT. Funding support for resource sharing is non-existent. There is no budget appropriated for sending materials to another library - or even for returning borrowed 16 mm films. Money from school fund raisers (book fairs, school pictures, sales) is used for mailing and photocopying is hopefully absorbed in the consumable materials budget.

HUMAN SUPPORT. Every community has more than one type of library. In Phase One the school media professionals meet with each other but rarely meet with librarians from other types of libraries in the community. Requests for borrowing from other libraries are casual and infrequent. There is no formal interlibrary loan agreement.

School media specialists are aware of external resources. They attend meetings, read professional journals, and have all read *Information Power* with the challenge "To participate in networks that enhance access to resources located outside the school" (AASL, 1988, 12). However, during Phase One of the School Networking Innovation Model, there is no concerted effort at the system level to support cooperative activities.

ACTIVITIES AND APPLICATIONS. In the fourth area, evidence of sharing is just beginning. Lists of serial holdings may be exchanged between librarians. Awareness of holdings of other libraries is necessary before regular requests can be made. At this stage, the patron is either sent to the other library to read the article or possibly a phone call will result in a photo copy of the article being mailed to the school. Lists of other special collections may begin at this phase. Some schools develop strengths in certain subjects to support unique curricular offerings. During this phase media specialists are becoming aware of different material delivery methods. Most school systems have a couriers. Other methods of delivery include dropping materials off in a central location after school or commercial carrier services.

The transition into the next phase will be uneven, depending upon circumstances. School district funding for technology may show movement into phase two while the human factor lags behind. In some locations human networking may take place since funding is not a prerequisite to librarians meeting with librarians for mutual decisions to cooperate in certain activities.

PHASE TWO

TECHNOLOGICAL SUPPORT. During Phase Two, the media specialist is beginning to use the microcomputer periodically, probably in the media center. There is still no modem to use to connect to external resources; however, efforts to obtain a telephone line in the media center have increased. The awareness of emerging technologies has intensified into investigation of services and prices. Terms such as retrospective conversion, MARC record, computer interface, DOS, print drivers, hard disk drives, laser printer, video overlay card, telefax, communications package, modem, DIALOG, Dow-Jones, FrEd Mail, WeatherLink, OCLC, CD-ROM drive, and video disc player creep into media specialists' talks with teachers and administrators.

FINANCIAL SUPPORT. Requests for budgeted support of interlibrary loan and resource sharing are beginning to appear in proposed budgets. Documentation to support the requests are prepared.

HUMAN SUPPORT. As schools move from Phase One into Phase Two, the informal meetings of local librarians are becoming regular with discussions on cooperative projects. Requests for interlibrary loan may be centralized and preliminary policies for resource sharing are being formed. A school system may request a system-level supervisor for media services, if such a position is not already established.

ACTIVITIES AND APPLICATIONS. The activities begun during Phase One, are expanded during the next phase. The lists of serials and/or special collections are combined into union lists. The concept of cooperative collection development expands as professionals from multi-type libraries discuss and plan purchases of periodicals and materials. The group may explore possibilities for centralized processing of materials, a savings in time and dollars.

At one time, networks considered only physical delivery of materials. The items had to be mailed, sent by commercial carrier, state courier, or sent through a local shuttle or courier service. Some libraries have set up a central location - the public library, for example. Someone assumes responsibility for picking up the items, often on the way to or from work. Methods of delivering interlibrary loan materials are explored during Phase Two. Students are taught to use the serials lists from other libraries.

The advantages of resource sharing and cooperative collection endeavors lead libraries into phase three. Again, movement is usually uneven. A system may be moving into phase three with technological support yet lag behind in cooperative activities with other types of libraries. Movement is influenced by opportunities that differ from community to community.

PHASE THREE

TECHNOLOGICAL SUPPORT. As schools move into Phase Three of the model, computers are used regularly for correspondence, sign creation, reports, and publications. The publications include periodic newsletters, bibliographies for instruction or recreation, and teaching materials. In addition, the computer has become a standard tool for library management: overdue notification, circulation records and reports, inventory of equipment, books, and audio-visual materials. The microcomputer has been often referred to as "another member of the media center staff."

The telephone and modem are used for online database searching, electronic mail services, and interlibrary loan requests. A telefax machine is used to send and receive interlibrary loan requests for periodical articles. Reference services are enhanced with the use of newer technologies such as CD-ROM encyclopedias and indexes. In addition to the word

FINANCIAL SUPPORT. A school system has moved into Phase Three when the costs of interlibrary loan activities are included in the budget for media services. The communication expenses and network fees are supported by the school system budget.

HUMAN SUPPORT. Local librarians are formally organized with written policies concerning interlibrary loan, cooperative endeavors, shared staff development programs, and the staff to accommodate a strong unified media services program. Casual requests for interlibrary loans have resulted in written policies for borrowing and loaning materials within the area. Concerns of teachers over "materials they ordered for their school" and of school administrators about "materials purchased with school money" (taxpayers' money) must be addressed in these policies. For school systems without media supervisors, the members of community librarian organizations become consultants, advisors, and moral supporters with the unified goal of providing information to the citizens of the community.

ACTIVITIES AND APPLICATIONS. The list of serials and collections has grown into a union catalog. It may take the form of a CD-ROM union catalog or an online catalog.

As the librarians in a community become more aware of the holdings of other libraries, purchasing decisions are for cooperative collection development. Library A will subscribe to *Journal Z* and Library B will subscribe to *Journal Y*. Neither is used frequently for pleasure reading but both are indexed in the standard periodical indexes. Library C will purchase *Reference Set W* and

Library D will purchase *Reference Set X*. In effect, these four libraries have quadrupled their buying power.

The expense of technical services, primarily processing new materials, may be shared. Whether a card catalog or an online catalog is used, if one site serves several libraries, overall costs decline. One suggestion is for a school system to hire a paraprofessional to work in the technical services department at the public library. Receiving orders, verifying invoices, cataloging, and preparing materials for circulation is done at the site. For media specialists this shifts time spent on things to time spent with people, service.

To move materials from library to patron requires one or more delivery systems. As the availability of telefax machines increases, copies of articles in journals and/or reference books are transmitted quickly. Within a local community, the only cost is the phone line and the paper - and the time for workers to handle the request.

Students are taught to include external resources while working on term papers.

Four areas that influence resource sharing have been discussed: technology, funding, humans, and activities. These are not meant to exclude other areas, but they have been identified as essential. Research supports that these areas are indeed important to a school becoming a participating member of library networking.

RESOURCES

American Association of School Librarians and Association for Educational Communications and Technology. *Information Power: Guidelines for School Library Media Programs.* Chicago and Washington, DC: ALA and AECT, 1988.

Kester, Diane D. *Modeling the School System Adoption Process for Library Networking.* Dissertation from the University of North Carolina at Chapel Hill. Chapel Hill, 1990. Published by UMI.

Title:

Educational Computing: Social Considerations

A SYMPOSIUM

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Educational Computing: Social Considerations

This symposium presented a collection of four related papers and viewpoints about the social, political, and economic issues surrounding the use of computers in schools. Participants in this session hoped to make the audience aware of some of the major social issues surrounding the use of computers in education, cause them to reflect upon the effects of particular research findings and applications currently being implemented in education, and provide direction for those in positions to implement educational innovations.

Each of five presenters provided an important perspective on educational issues related to the use of computer technology in schools, its conceptualization, practices, effects, or implications. We hoped to provide a collection of ideas that have been traditionally ignored in teacher education and graduate studies, but beg to be addressed. It is from this perspective that we formed the contents and context of this symposium.

Each presenter addressed a particular aspect of a critical social issue related to the presence of computers in the schools. These issues include the teacher's changing role and the effects of computers on teachers, students, curriculum and knowledge; the question of education as a marketplace; copyright concerns and implications for educational practice; and finally, instructional design and human praxis.

EDUCATIONAL COMPUTING AND SCHOOL CHANGE: INFLUENCES ON TEACHERS' ROLES AND PEDAGOGY

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Technological advancements have stimulated the widespread diffusion of microcomputers across all levels of our economy and society, thus creating a demand for substantive computer education. This computer education includes learning about computers as well as learning with computers.

Learning about computers changes the curriculum in an obvious way while learning with computers changes the curriculum and pedagogy in ways that go beyond the obvious. Furthermore, those changes reach beyond the school curriculum as we know it and into the social, economic, and political structure of our lives.

Although parents, government, and school officials recognize that students must prepare for citizenship in a computer-based society, the mere acquisition of computers for the schools is but one small facet of the much larger and more complex task: the implementation of this potentially significant innovation in education and the consequent formation of durable patterns of computer use and application by students and teachers long into the future.

The careful planning and proper implementation of informed computer education agendas, free from unreasonable expectations, will determine the value of this innovation (Goodlad, 1975; Romberg & Price, 1981). Further, the success of any such implementation effort will depend largely upon the teachers who determine the daily school activities (Cuban, 1986). Indeed, the personal and professional relationships among teachers, students, and administrators can have a greater influence on the future of any proposed innovation than the most generous outlays of money and machines.

The computer's conquest of American schools is more sweeping and complete than that of any technological innovation in memory. Around the country, principals, teachers, and parents point with pride to the serried ranks of monitor screens in their school computing labs while they battle with legislators over funding for more machines and software. Indeed, the question of implementing computer technology has already shifted from the problem of acquiring and finding uses for computers to the problem of handling existing sets of systems, software, and computer skills already in place.

The ironies of the situation are remarkable: a machine designed simply to process and transmit information has become the tool of choice in the school system's campaign to foster literacy, transmit culture, inculcate basic civic values, and train students for a competitive economy. It is perhaps understandable that a machine touted as the vanguard of the great new age of information processing and control would be so critical to yet another of American education's countless crusades to improve society (Ravitch, 1988). And like other educational innovations, the ongoing integration of computers into education occurs in an atmosphere clouded by bewilderment, optimism, confusion, skepticism, prejudice, and hope.

An accurate view of educational change and implementation of innovations considers the potential alterations that innovations cause in the school's learning environment (Berman, 1981; Berman & McLaughlin, 1978; Sarason, 1982). For example, the introduction of computers might change the grouping of students or the amount and quality of interactions between students and teachers, or the very pedagogy of lesson structure. Further, recent research indicates that changes in teachers' roles are emerging, which in turn change their relationships with other teachers and with administrators.

Implementing computer technology in schools has brought about some obvious changes along with changes which are more subtle, yet carry a full impact. These changes affect individual lesson pedagogy as well as the overall curriculum strategy, the relationship between teachers, the emphasis of inservice training, specific teaching duties, and changes in institutional structure. The subtle changes can be just as powerful as the more obvious changes concerning their social effects on schools.

It is a commonplace to note that the student lies at the center of this drama, while the teacher's role in the acceptance, implementation, and outcome of educational computing has received less attention, even though an overwhelming body of evidence points to the centrality of teachers in the process of educational innovation. It is most important to realize that the teachers' existing attitudes, skills, and working habits will have great influence on their acceptance, style of implementation, and outcome regarding educational computing (see Figure 1). The interaction between the teacher and the computer has multiple dimensions way beyond the obvious problems of the machine's efficacy with students. We must ask, for example, the following questions.

How does the broad spectrum of teachers' attitudes about computers and their desirability limit or enhance the coordination of computers with the curriculum? Do teachers' prejudices about computers, independent of their biases about the social or educational condition of students, affect the way computers are located, controlled, and used in schools? How do teachers' fears and expectations about the impact of computers on their workloads, daily routines, and control over students and classtime affect their decisions about supervising and grouping students for computer use? These questions, part of what might be termed the sociology of educational computing, point directly to the teacher's role in implementing computers.

Social Interaction Model of Implementing Computers

The current method of implementing computers in the schools is based on a "social interaction" approach that stresses the careful integration of practical ideas promoted by teachers with the directed support of the administration, parents and local community (Knupfer, 1987). Together these key people provide the necessary practicality and the directed support from outside forces upon which the daily life of classrooms is built. Teachers who develop workable strategies for using computers have a stronger claim on the vital support of administrators and parents who lack practical experience with educational computing but who want to see it succeed. Implementation through social interaction hinges, then, on the ways that teachers transform the opportunities afforded by an innovation into practical, meaningful classroom applications of this technology (see Figure 2).

The teachers' role in the social interaction is crucial, and it depends largely on the preconceptions teachers bring to the implementation of an innovation. Their attitudes about change in the school; their social prejudices about race, class, and gender; their assessments of the students' different ability levels and how to handle them; and their sense of their own professional status and the uncertainties surrounding that status all affect they way they treat educational computing.

Further, as the teachers grope with implementing computers into the schools as we know them, they realize that schooling itself is changing. This change is brought about not only by demands of a changing society, but also by the very presence of computers in the schools. The computers enable the teachers to structure lessons quite differently and in so doing, change the entire process, focus, and outcomes of educational expectations. Teachers are not only directing their students to realize different educational outcomes as a result of using computers, but they are also engaging in different roles as students experience different processes of learning. The teacher's role is no longer focused on providing information nor is it to be a straight forward facilitator as was believed in the early stages of educational computing. Instead the teacher's role is emerging as learning partner and collaborator in the educational process.

References

Berman, P. (1981). Toward an implementation paradigm. In R. Lehming and M. Kane (Eds.), *Improving Schools*. Beverly Hills, CA: Sage.

Berman, P. & McLaughlin, M. (1978). *Federal programs supporting educational change, vol. VIII, implementing and sustaining innovations*. Santa Monica, CA: Rand Corporation.

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920*. New York: Teachers College Press.

Goodlad, J. (1975). *The dynamics of educational change*. Toronto: McGraw-Hill.

Knupfer, N. N. (1987). *A survey of teacher's perceptions, opinions, and attitudes about instructional computing: Implications regarding equity*. Doctoral Dissertation: University of Wisconsin.

Ravitch, D. (1988). *The Troubled Crusade: American Education Since 1945*. New York: Basic Books.

Romberg, T. & Price, G. (1981, February). *Assimilation of Innovations into the Culture of Schools: Impediments to Radical Change*. Paper presented at teh NIE Conference on Issues Related to the Implementation of Computer Technology in Schools, Washington, D.C.

Sarason, S. B. (1982). *The culture of the school and the problem of change*. Boston, MA: Allyn and Bacon, Incorporated.

Figure 1. *Educational Computing and Teachers*

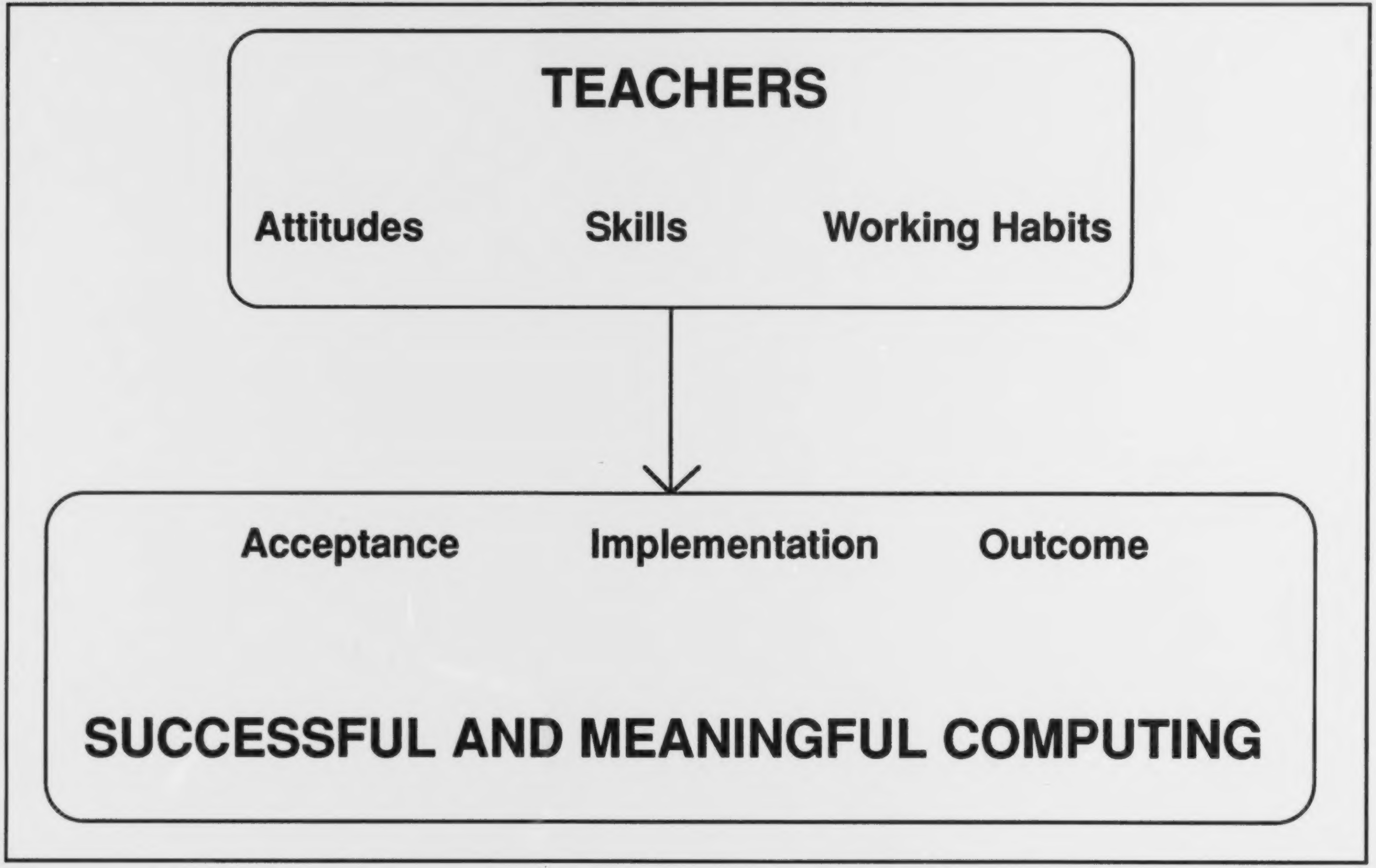
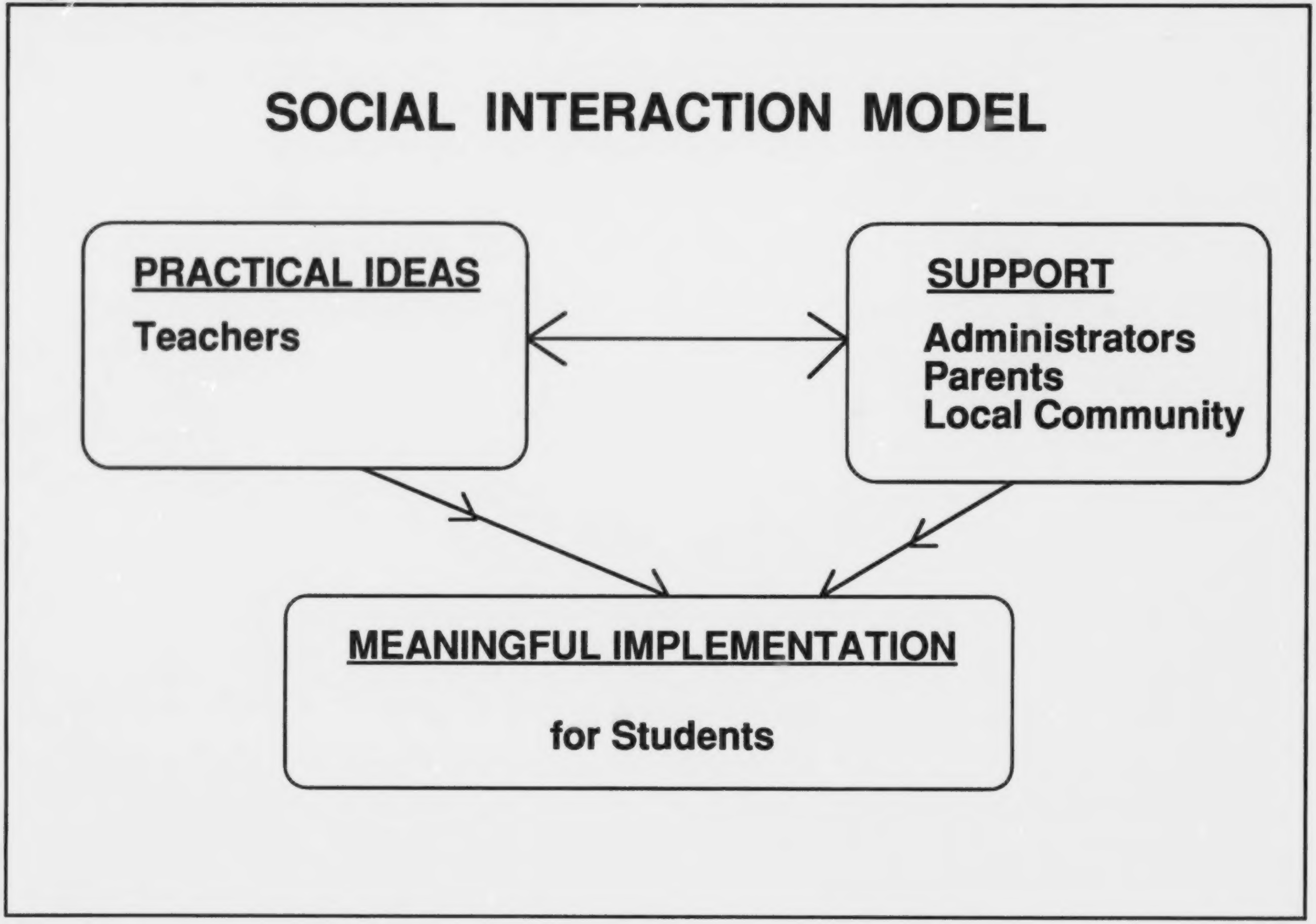

TEACHERS
Attitudes
Skills
Working Habits
Acceptance
Implementation
Outcome
SUCCESSFUL AND MEANINGFUL COMPUTING

Figure 2. *Social Interaction Model*


SOCIAL INTERACTION MODEL
PRACTICAL IDEAS
Teachers
SUPPORT
Administrators
Parents
Local Community
MEANINGFUL IMPLEMENTATION
for Students

Education as Marketplace

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The exponential rise in computer education in the 1980s is usually attributed to the technological innovations which made the microcomputer an affordable machine. Yet, there were many other forces which contributed to the widespread adoption of computer literacy into the curriculum. This paper focuses in on corporate needs and political aims which united to convince educators and much of the general public that we were all suffering from a previously unknown "disease" (computer illiteracy) and that curriculum reform was necessary before this reached epidemic proportions.

This paper concentrates on the twin needs for a trained workforce and to keep our country ahead of others in the areas of economics, research, and science/technology. First it sets the historical context by showing that these needs were driving forces behind the first public education programs, through early vocational training, to the increase in science and technology education in the wake of the launch of Sputnik. It then looks carefully at the moves towards computer education in the 1980s, looking both at which groups of people were the leading advocates and what they stood to gain by this, as well as examining the curriculum itself and whether in retrospect one could say that it was really designed to meet such a pressing need as that vocalized by the leading proponents of computer literacy requirements.

After a detailed historical examination of these issues, the paper points to the following set of conclusions:

Personal computers first appeared in the classroom during a period of major curricular reform and must be viewed within that context. The *back to basics* movement of that period was grounded in the perception that educational reform was necessary to prevent the United States from losing its competitive edge internationally (both economically and politically). Recommendations tended to stress math and science instruction, vocational training, and computer literacy.

Major advocates of computer literacy included corporations, higher education leaders, the military, the federal government, and the scientific community. The corporate world saw mandatory computer literacy as a way of creating a more trained workforce through direct computing skills (such as the use of particular software packages), as well as general skills and habits (working alone for many hours without any human contact, responding to linear/multiple choice situations, etc.). Computer corporations saw this as a way to promote popular interest and support for their activities, as well as a way create a demand for their own particular products. Higher education, the military, the federal government, and the scientific community all viewed computer education as a tool both for maintaining a competitive edge internationally and for securing additional funding for their own agendas which intersected with this.

Advocates from all these areas promoted computer education as a cornerstone of maintaining *progress*. Yet this was a strictly technological view of progress, where humanistic aspects of progress (such as decreasing stratification) were seldom mentioned. They often argued that computer literacy was necessary in order to be a "good citizen" in this society, yet we have seen that few (if any) computer literacy programs discuss the social impact of computers in any meaningful way.

In fact, computer literacy curricula seems to fail even on the level of delivering meaningful vocational skills (due to the rapid technological developments that are changing the nature of computing skills on an almost annual basis). What we are left with is curricula that seems effective in getting people habituated to dealing with computers: typing on keyboards in response to messages on a screen, working without the physical presence of other humans, and thinking in ways that computers (today) require. This is not too different than early public education's function of socializing students in preparation for factory labor.

None of this should be surprising. As the historical examination in the paper has shown, the history of public education has been shaped by the corporate need for a trained workforce and the competitive need to keep America ahead economically and politically.. Since the industrial revolution the notion of *progress* has become an unquestioned assumption which our society pursues. The movement for computer literacy in the 1980s has been shaped by the same social forces which have dominated public education since the middle of the last century. As long as the forces that shape the rest of society remain basically unchanged, we can expect future successful movements for educational reform to be subject to similar influences.

Computers and Copyright: The Unpopular Dilemma

Abstract

The increasing use of microcomputers in schools across the nation is paralleled by a growing concern that computer technology be used responsibly. One of the many concerns associated with responsible use of computers is the issue of copyright. Educators are, or should be, particularly sensitive to copyright issues. Yet, the problem of computer-related copyright violations in schools continues to be one of national concern. The purpose of this paper is to: 1) briefly explore microcomputer copyright issues in the context of educational use, 2) outline considerations for educators interested in taking steps to resolve some of the problems associated with computers and copyright issues, and 3) raise additional social issues associated with copyright laws and the educational use of microcomputers and emerging computer-based technologies.

Computers, Classrooms, and Copyright

Computers offer a variety of instructional advantages in the classroom, yet the increasing number of microcomputers in schools across the nation has generated significant concern regarding associated ethical and legal responsibilities of computer-using educators and students. The implications which copyright legislation and guidelines have for the judicious use of computer hardware and software is an area in which concern is growing as the number of computers in schools increases. The misuse of hardware and the illegal duplication and abuse of software in violation of federal copyright legislation have risen to epidemic proportions (Brunner, 1988; Bullock, 1986; Thornburg, 1986). And though the severity of the copyright problem has been documented, few solutions to the copyright quandary have been offered.

Unfortunately, computer technology has evolved faster than the legislation which governs its use, and current copyright laws and guidelines are somewhat ineffective in providing direction for a concerned public (Brunner, 1988; Sacks, 1985; Talab, 1986, White & Hubbard, 1988). It also appears that the existing copyright laws and guidelines are not widely acknowledged by educators. Many concerned observers (ADAPSO, 1984; Bullock, 1986; EDUCOM & ADAPSO, 1987; Helm, 1984; Thornburg, 1986) call for educators to increase their awareness of copyright legislation and guidelines, believing, perhaps naively, that increased knowledge of the law will result in increased adherence to copyright legislation. But as Helm (1985) asserts, when educators violate computer-related copyright laws, "Some do so in blissful ignorance, others with vague intuitions of wrong-doing, and regrettably a few knowingly and blatantly ignore the frustrating restrictions contained in the copyright law" (p. 2). Awareness of copyright laws and guidelines may serve to enlighten the ignorant and vaguely uncomfortable copyright offenders, but few sources offer suggestions for convincing the cognizant infringers that their actions are unethical and illegal according to federal statutes.

Educators often assert that their responsibilities as teachers absolve them from adherence to the copyright laws. Educators may claim that copyright violations are justified by their noble goals of providing the best possible educational experiences for students. But the use of microcomputers in educational settings does not justify illegal actions, and teachers and students must be held accountable for their uses of microcomputer technology.

Though copyright legislation and guidelines pertain to the uses of computer hardware and software in businesses and homes as well as in schools, the misuse of computer technology in schools is of particular concern. As Bear (1986, p. 114) notes, schools are one of the most powerful and pervasive influences on the ethics and morals of young people and schools must prepare students to "recognize, comprehend, and evaluate the general impact of computers, as well as specific issues involving the use of computers." Schools, therefore, have an obligation to introduce students to the legal responsibilities of computer use, including copyright laws and guidelines. In addition to teaching students about the implications of copyright legislation for computer use, teachers also are called upon to serve as role models who demonstrate ethical and appropriate uses of computer technology and who are aware of and adhere to copyright guidelines in their professional practice (Bullock, 1986; Niemeyer, 1986). To further complicate the situation, the dilemma of encouraging educators and students to abide by copyright laws and guidelines is one which will be exacerbated by the development of new computer-based technologies before many of the existing copyright problems are resolved.

Technological Advances and Copyright Concerns

Though the Copyright Act of 1976 and subsequent 1980 amendments provide basic guidance for the legal uses of computer hardware and software, advances in technology already have created a need for additional and more inclusive copyright legislation and guidelines. For example, a variety of computer-accessed informational, interactive, and multimedia options such as compact audio discs, video discs, video tape, electronic databases, and bulletin boards can be linked by computers to provide educational and informational opportunities for students and teachers. Students and teachers certainly can use these types of hardware and software legally and advantageously in classrooms. However, they also can engage in electronic cut-and-paste techniques to incorporate information directly from these resources into their own products. This accessibility of information and resources not only raises issues of electronic plagiarism and privacy of information, but also raises copyright concerns.

Though some electronically-accessed words, sound, and images are authorized for use in classroom productions, access to these sources of computer-based information creates numerous copyright problems that are not as yet clarified in the laws and guidelines. Teachers and students must be made aware of the responsible uses of computer-accessed multimedia and informational resources in much the same way that they must be made aware of copyright guidelines directing the use of more traditional media such as film, audio cassettes, and videotape. While D'Ignazio (1990) stresses that both teachers and students must become aware of copyright issues arising from the use of multimedia resources, he also acknowledges that current copyright laws provide little clear guidance in dealing with problems created by emerging technologies.

Computer-related copyright issues relating to multimedia resources and emerging technologies may require familiarity with guidelines and legislation pertaining to existing laws addressing computer, print, video, audio, and other formats if students and educators are to use the new hardware and software in an ethical manner. But in order to use copyrighted materials within the law and to teach students the legal responsibilities associated with the use of computers and multimedia hardware and software, educators will need to constantly monitor the copyright laws and their implications for the uses of emerging technologies. Unfortunately, the technologies emerge more rapidly and also are more readily acknowledged than do the laws and guidelines developed to oversee their use.

Educators and the Future of Copyright Law

Efforts can be made to encourage teachers to abide by the copyright laws, but it will take the concerted efforts of the entire educational community to resolve many of the issues and questions associated with the legal uses of computer hardware and software. Not only teachers and students, but administrators, district coordinators and supervisors, library media specialists, support staff, and parents must cooperate to increase awareness of and adherence to existing copyright laws regarding the use of computers in schools. But the educational community has an important responsibility in addition to raising awareness of copyright laws and encouraging teachers and students to abide by them. As Brunner suggests, "Society must either uphold the current laws or change the present laws in accordance with their beliefs" (1988, p. 17). Those concerned about the educational uses of microcomputer hardware and software may believe that the current copyright laws are inappropriate in an increasingly technological society. Those with this conviction should serve as advocates for changing and clarifying copyright legislation to keep pace with technological innovations. As noted earlier, the copyright laws have traditionally failed to adequately address issues generated by advances in technology, and this trend continues. Educators who are bewildered and frustrated by the lack of guidance which current laws provide or who believe that educational uses of computer technology demand more consideration than is currently afforded by the law must become actively involved in the resolution of these and other computer-related copyright issues.

It is important for teachers and students to know and to abide by existing copyright legislation, but it is also important for those who live under the law to voice their needs and convictions. The generation of copyright law has been an attempt to balance the rights of owners of copyrighted works with the needs of those who use the works, and the act of balancing is not a static process. It is up to the educational community to adhere to current laws or to advocate a new legal balance. What must not continue is the blatant disregard for computer-related copyright laws often demonstrated by educators. Educators must be responsible for their use of existing and emerging technologies and by their consistent words and actions must encourage students to do likewise. Until copyright laws are modified, an event for which educators are at least partially responsible, teachers and students must know and abide by existing copyright laws and their implications for the responsible use of computer hardware and software.

Copyright, Computers, and the Broader Social Context

The suggestion that educators should advocate changes in copyright laws raises the legitimate question of for whose benefit copyright legislation is enacted. As indicated above, the original intent of copyright law was to balance the needs of those who use copyrighted materials with the rights of those who own the copyright to the creative endeavors. The fact that educators wish to use copyrighted materials in non-profit educational contexts does not grant them permission to do so indiscriminately. Though educators are granted some latitude in the use of copyrighted materials, as outlined in the Fair Use Doctrine and other copyright legislation and guidelines, copyright laws nevertheless limit the educational uses of materials, including the educational uses of computer hardware and software.

Some of these limits to the educational uses of computer hardware and software are quite apparent and are spelled out in legislation and guidelines concerning issues such as the duplication of software, site licensing, and networking. However, the limits to the educational uses of computers that are indicated by copyright legislation are often more subtle and raise questions about the educational uses of copyrighted computer materials as part of the larger social context. For example, educational organizations which adhere to copyright legislation and guidelines would necessarily need to allocate more funds for the purchase of software than would those who illegally duplicate software. Certainly, software producers suffer financially when educators pirate software, but what is the cost to students, teachers, and society when school districts financially cannot provide access to copyrighted computer software? Will students in financially less affluent districts have access to instruction and information provided through computer-based platforms, and if not, how will this deficit impact society? Certainly, inequities in funding have existed for years in school districts across the nation and continue to plague education. But the potential of computer hardware and software to provide both instruction and information once more underscores the issue of equitable access to the tools of education and the keys to knowledge. If copyright legislation prohibits students in less affluent districts from access to computer-based instruction and information, are the laws in the best interest of society? If not, how should they be modified to reflect the changing needs of education and society that have been precipitated by advances in technology? And how can the needs of students and educators be balanced with the rights of those whose creative efforts result in computer hardware and software traditionally protected by copyright legislation?

Obviously, there are no easy answers to these questions. Existing legislation suggests an ethical code of behavior for educators as discussed above, but issues regarding the educational uses of computers in the larger social context generate questions that are as yet unresolved and that eventually may lead to a new social ethic as well as to new legal guidelines for the educational uses of copyrighted computer-based materials.

References

ADAPSO. (1984). Thou shalt not dupe. (Available from ADAPSO, Suite 300, 1300 North 17th Street, Arlington, VA 22209)

Bear, G. G. (1986). Teaching computer ethics: Why, what, who, when, and how. Computers in the Schools, 3(2), 113-118.

Brunner, R. B. (1988). Legal, societal, and ethical issues concerning intellectual rights in computer education. (ERIC Document Reproduction Service No. ED 299 678)

Bullock, L. C. (1986). Shoplifting? No, softlifting! (ERIC Document Reproduction Service No. ED 278 376)

EDUCOM, & ADAPSO. (1987). Using software. (Available from EDUCOM Software Initiative, P.O. Box 364, Princeton, NJ 08540)

Helm, V. (1984). Software quality and copyright: Issues in computer-assisted instruction. Washington, DC: Association for Educational Communications and Technology.

Helm, V. M. (1985). Copyright issues in computer-assisted instruction. (ERIC Document Reproduction Service No. ED 268 668)

Niemeyer, K. K. (1986). Copyright policy and guidelines for use of copyrighted materials. (ERIC Document Reproduction Service No. ED 282 573)

Sacks, J. (1985, October). To copy-protect or not to copy-protect? Popular Computing, pp. 73-75, 125.

Talab, R. S. (1986). Commonsense copyright: A guide to the new technologies. Jefferson, NC: McFarland & Company.

Thornburg, D. D. (1986, March). What's turning teachers into thieves? A+ Magazine, pp. 93-94.

White, C. S., & Hubbard G. (1988). Computers and education. NY: Macmillan.

Title:

Tessellating with Logo: Effects on Visual Literacy

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Educational computing offers a wealth of opportunities to teach through the use of one's visual sense. That visualization can be used to develop higher-order thinking skills in a way that is quite different from a text-based approach to teaching and learning. Yet, the content of many computer-based lessons and their accompanying images on the screen often neglect this potential mode of teaching. This paper reports a study that investigated the potential of the Logo programming language to develop visual literacy skill in elementary school students.

PURPOSE

The purpose of this research was to investigate the potential of a Logo environment to develop visual literacy and recognition of Escher-type geometric constructions within second grade and sixth grade students. Specifically, the following questions were asked. Can students use higher-order and creative thinking skills in relation to using computers to create mathematical tessellations and art? Can students create Escher-like tessellations using Logo? Does this enhance their visual literacy and visual perception? Can students transfer that knowledge when looking at the prints of M.C. Escher and describe the more obvious figures and the underlying geometrical shapes within Escher's prints?

BACKGROUND

Through the cognitive and organizational processes of thinking, one develops literacy in the visual and verbal domains. "Visual literacy is the active reconstruction of past visual experience with incoming visual messages to obtain meaning" (Sinatra, 1986, p. 5). Visual information is sent to the brain where it is interpreted and modified in light of past experiences. This process begins early in life and precedes or develops concurrently with oral literacy (Sinatra, 1986).

Visual literacy is the ability to not only understand paintings, photographs, film, and other visual media, but also the ability to communicate or express oneself with at least one visual medium (Curtiss, 1987). It draws its meaning from the way one thinks visually, creates new knowledge, and uses thinking skills beyond those which are basic in the approach to learning. These skills often employ higher-order thinking which challenges the traditional path of problem solving and applies different approaches to learning. These different approaches call upon different learning styles as each situation demands.

Our visual awareness, which is how we see, and our visual perception, which is how we view objects of nature and their relationship to the space around them, help us to seek, uncover and construct new ideas. For centuries, nature and its objects have been viewed from the constructs of Galileo's "geometricizing physics" (Jones, 1989, p. 8). Within this construct nature is perceived solely in terms of its geometrical patterns and mathematical physics.

Geometry, for example, has provided a systematic method of understanding shapes and their transformation within space.

To have an understanding of shapes within space is a "perceptual consciousness" (Jones, 1989, p. 124). An awareness of spatiality is vital and important in creating new knowledge. Just as nature has been defined for centuries by scientists and mathematicians, so too have artists visualized objects in space through their paintings, sculptures, and other media. They discover space through artistic expression rather than mathematical induction.

But artists and mathematicians rarely mix their discoveries. As forms of expression, the arts and mathematics have not been assimilated by artists or scientists. This is often due to the unwritten doctrine that artists should not practice intellectuality in their work (Locher, 1988).

Escher, however, combined the ideas of the empirical world as an illusion with mathematical representations of that world. The mathematics represented the unifying principle upon which a work was constructed and arranged (Thornburg, 1983). Escher's prints conveyed his ability to balance perfect forms and structures with the idea that everything is simply an illusion (Locher, 1988). These artistic renderings of illusory geometric shapes rotating about a point in space generate a mathematical beauty which has the ability to please the senses and elate the mind of the viewer.

Viewing Escher's works, appreciating Escher's vision and mathematical ideas, and being able to describe what is visually present requires conceptual thinking. Arnheim (1974) describes this form of reasoning as an artistic activity and claims that the process calls upon perception and thought which are intertwined in an indivisible manner. He posits that our senses employ impressions and experiences from which we form perceptions, which we then express through our thoughts. Arnheim indicates three elements that are necessary for human cognition: common characteristics that control perception in the nervous system and its reflections upon consciousness; constructing physical reality through the senses; and the properties inherent in media through which cognitive experiences take place (Arnheim, 1986). This process of visual conception is formed by one's intent, creative resourcefulness, and fresh ideas (Curtiss, 1987). Through this process of visual thinking we are able to evaluate our visual experiences and make visual statements regarding our perceptions.

Being visually literate is tantamount to being educationally well-rounded as a person. This premise has major implications for educators and the curriculum. According to Arnheim (1986), visual thinking promotes a continuous link between pictures and words, and between the arts and sciences. These links extend more broadly to encompass both language and images, as well as perceptual experience and theoretical reasoning. And because the structural properties of images, symmetry for example, drive the thinking, Arnheim advocates that teachers use specific rules related to pictorial composition and visual order when presenting new geometry concepts to students. Thus, students will be encouraged to think in terms of visual images.

Visual thinking as a primary medium of thought can be defined as having three components which include perceptual images, mental images, and graphic images (Erikkson,1988). Perceptual images are the ways we choose to see and interpret the external world. Mental images are the ways we invent, envision, create ideas to solve problems and integrate information. Graphic images are the visual codes and languages we use to communicate information.

According to Eriksson (1988), the visual nature of communication and the fact that visual images are the building blocks of data require a new language based upon verbal-visual cues. This requires educators and curriculum designers to emphasize visual literacy skills.

The computer has the potential to offer instruction based upon visualization. For example, images created on the computer screen can enhance the meaning of lessons. In addition particular software which is based upon visualization may have the potential of helping students develop visual literacy skills. For example, Logo uses visual elements which show students the results of structured procedures that they write. Knupfer (1991) recently reported some interesting patterns of increasing cognitive skill related to spatial scanning among students who used Logo during group activity. This research investigates the possibility that using Logo will help students develop visual literacy skills and spatial scanning as it relates to Escher-like tessellations.

METHOD

Subjects

Four classes of students participated in this study: two classes of second grade students and two classes of sixth grade students, totalling 110 students. All classes were heterogeneously mixed. One teacher instructed both second-grade classes and another teacher instructed both sixth-grade classes. None of the second graders had experience with Logo prior to this study, and approximately half of the sixth graders had been exposed to Logo during the previous school year.

A control group of 126 students was used; again, there were two classes of second-grade students and two classes of sixth-grade students. The control group was from a different school within the same geographical region and consisted of a similar population of students. The control group did not receive the Logo treatment and practice.

Tables one, two and three should the breakdown of subjects by treatment and control, grade level, gender, and racial group.

Materials

Pretest and Posttest. A pretest and posttest were conducted using Escher prints. Two prints were used for the pretest and three different prints, which had similar qualities in terms of this study, were used for the posttest. All prints had one or two figures and one geometric shape upon which the print was constructed. The pretest and the posttest each contained two colored prints along with one black and white print.

Software. LogoWriter (LCSI) was used as the software with which students practiced creating and tessellating shapes. The students created all geometric shapes, patterns, and tessellations within this software environment with the exception of one paper and pencil exercise that served as an introduction to the concept of tessellations. Use of the Logo language allowed the students to work within a microworld as Papert envisioned.

Escher Artwork. Samples of Escher artwork were displayed in the computer laboratory where the students had their classes. Also, a few books on Escher were placed within the school library for the students to check out.

Table 1. *Subjects by Grade and Treatment*

GRADE	TREATMENT	CONTROL	TOTAL
2nd	48	55	103
6th	64	71	135
TOTAL	112	126	238

Table 2. *Subjects by Grade and Gender*

GRADE	MALE	FEMALE	TOTAL
2nd	46	57	103
6th	70	65	135
TOTAL	116	122	238

Table 3. *Subjects by Racial Group*

	CAUCASIAN	HISPANIC	BLACK
COUNT	143	85	10
PERCENTAGE	60.1	35.7	4.2

Paper and Felt-tip Pens. One class period called for the introduction of tessellations using a paper-based activity in which the students created tessellations and colored patterns within them.

Procedure

This study was conducted during an entire spring semester; students used computers in a laboratory setting for one 40-minute session during each week. Most of the students worked in preassigned pairs. Students were individually pretested using two Escher prints. They were asked to describe the recognizable figures and geometric shapes that they saw in the prints.

Next, the students received instruction in creating shapes using the LogoWriter software. They were taught commands to first create the shape and then to write a procedure for constructing the shape. Initially, shapes were limited to squares, triangles, and hexagons so that students could tessellate their work. Once students mastered writing procedures, they were taught the MOVE command and practiced tiling their shapes vertically or horizontally on the screen. Finally, students were asked to tessellate their shapes and fill the screen with the tessellations.

In accordance with research on transfer of knowledge, once the foundations were laid, the students were given instruction on Escher prints and the Escher style of creating tessellations. Approximately twelve weeks into the study, one researcher taught a lesson to familiarize the students with Escher and the concept of tessellations within artwork. During a single class period, the students were shown examples of Escher artwork and were able to look for the figures and geometric shapes within it. Both the treatment and the control group were taught the Escher lesson, but the control group simply heard the lesson and received no ability to practice applying its concepts. On the other hand, after hearing the presentation and seeing some examples, the students in the treatment group were able to try creating a tessellation by first drawing a plan on a piece of paper and trying to create that plan on the computer.

During the final three weeks of the unit the sixth-grade students who had already mastered tessellating the computer screen with standard geometric shapes, were able to try more a more complicated task. Those students wrote procedures which pushed in and pulled out the sides of a square as part of the process of creating Escher-like shapes on the computer. Figure 1 shows an example of this type of work. The shape stands alone as it was created and then it is incorporated in a tessellating pattern. Students who were able to create more complicated patterns went on to design fancier tessellations like the one pictured in Figure 2.

The students continued to practice tessellating their shapes, printed the full-screen tessellations on paper, and drew Escher-like figures on their printouts with colorful felt-tip pens. Finally, the students were posttested using three additional Escher prints that they had not seen before. The posttest followed the same method as the pretest and the only variable was fresh prints to avoid the recognition of previous viewings. The control group received no Logo instruction and were simply given the pretest and posttest.

Teaching Style. The second-grade students were taught by one second-grade teacher who had previously worked as a computer lab teacher. The sixth-graders were taught by the current computer lab instructor. Both instructors were knowledgeable in the use of computers and LogoWriter. Their approaches to teaching with computers were similar, but their teaching styles were not. The second-grade teacher's style was gregarious, animated, and experientially oriented while the sixth-grade teacher's style was structured, linear, and oriented toward rote learning.

Figure 1
Shape and Tessellation of a Pushed In and Pulled Out Square

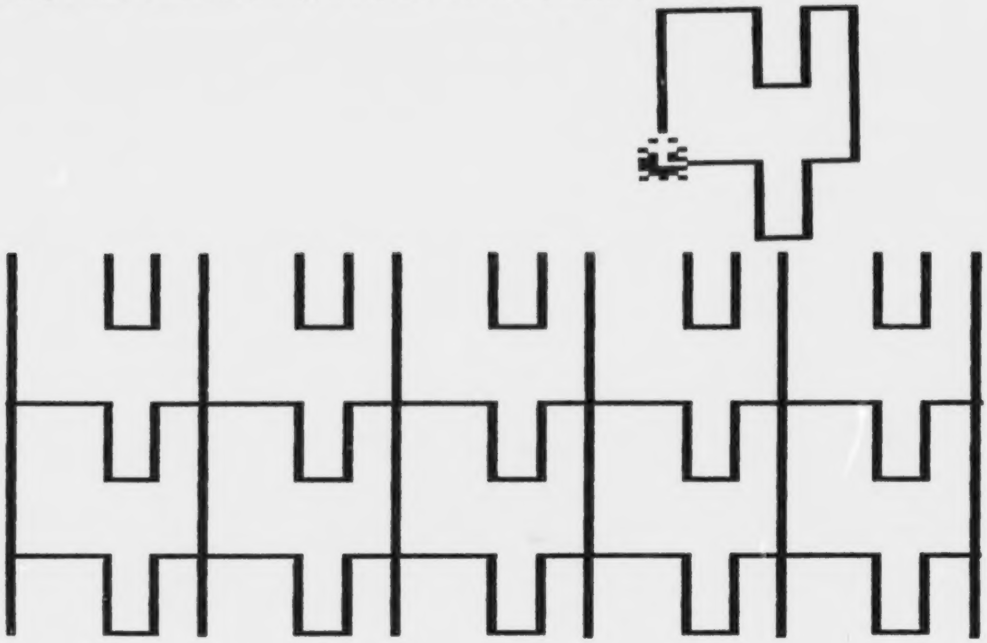
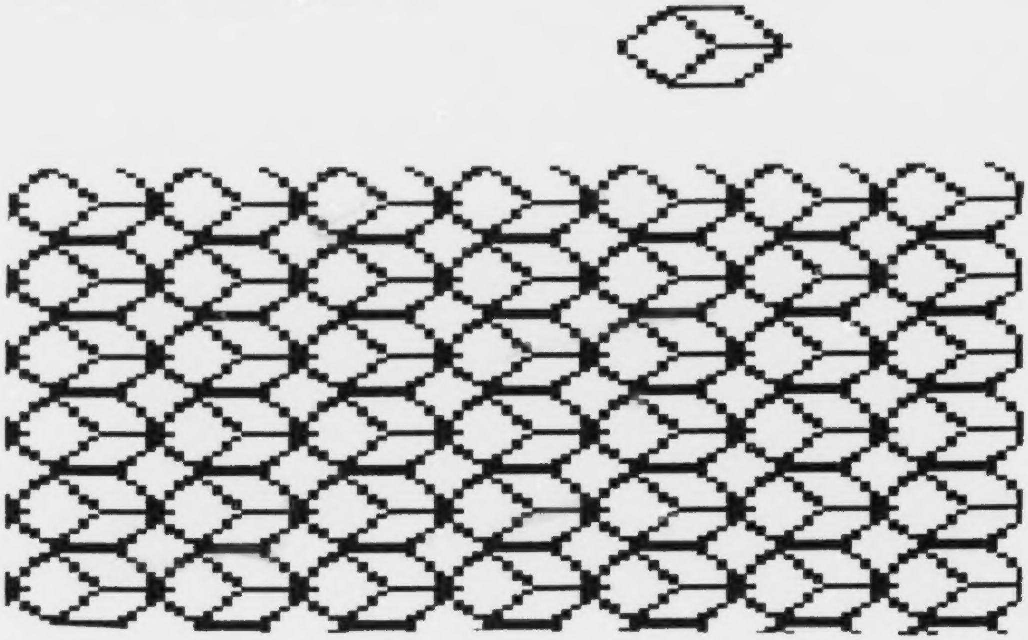


Figure 2
Shape and Tessellation of a Cube



Prior to beginning the Logo instruction, both teachers were given a script to guide them through the weekly lessons. The second-grade teacher began by following the script but changed the script in consultation with the researchers when he felt the students needed more time to work on understanding particular concepts, such as how to make the turtle move or the meaning of tessellation. The sixth-grade teacher followed his own course of study with the unit and ignored the script from the beginning.

Analysis

The independent variables for analysis were Logo treatment and grade level. The dependent variables were figure and geometric shape identification. ANOVA determined that there were no significant differences in the pretest scores for either figure or shape identification among the student groups. The posttest scores were analyzed using a 2 X 2 ANOVA (grade level by treatment group) and t-test between treatments within each grade level. The analysis, which follows, allowed some conclusions to be drawn about the feasibility of using Logo to enhance visual literacy and spatial scanning skills which might transfer to the ability to recognize Escher-type geometric patterns of figures and shapes. The alpha level for significance was set at .05.

RESULTS AND CONCLUSIONS

There were two dependent variables in question for the analysis; figures and geometric shapes. Table 4 lists the means and standard deviations for The ANOVA for figure identification revealed significant main effects for both treatment and grade, but no significant interactions (see Table 5). One could interpret this to mean that the students who received the Logo practice did better than those who did not receive Logo. In addition students in the sixth grade recognized more figures than did the second grade students. However, there is no interaction between those main effects.

The ANOVA for geometric shape identification revealed significant differences for the main effects as well as an interaction between the independent variables of treatment and grade (see Table 6). This indicates that sixth grade students identified significantly more shapes than did second grade students, and those in the treatment group identified more shapes than those in the control group. Further, the older students who received the treatment identified the most geometric shapes.

Student Attitudes. Throughout the study the students remained interested in the daily tasks. The second-graders experienced some frustration, but because the teacher was alert to its signs, adjustments were made to the lessons which allowed students to proceed at a more comfortable level. The sixth graders demonstrated various levels of enthusiasm. Some students worked ardently, while others did not remain on task.

Once the students began to be successful with the tessellations, their interest level increased; this was true of both grade levels. After the lesson on Escher and his artwork, the students showed a remarkable interest in the activity. Some second graders were heard to remark that they were going to "play artist" after school and some of the sixth graders checked out books on Escher from the library. Students at both grade levels wanted to know where they could find other things by Escher. For example, the researcher had shown the students a tote bag, some wrapping paper, and some posters contained Escher prints, and the students wanted to buy some of those things for themselves. They were also interested in finding more books about Escher at the public library.

Table 4. *Means and Standard Deviations on Posttest*

		FIGURES		GEOMETRIC SHAPES	
GROUP	n	M	SD	M	SD
2nd Grade Treatment	48	2.71	.62	1.35	1.02
2nd Grade Control	55	2.45	.86	.18	.51
6th Grade Treatment	64	2.92	.42	2.12	.88
6th Grade Control	71	2.85	.32	0.30	.52

Table 5. *ANOVA for Figure Identification (Treatment by Grade)*

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio	F Prob.
Treatment (A)	1	1.30	1.30	3.95	.048*
Grade Level (B)	1	5.79	5.79	17.66	.000*
Treatment X Grade (AB)	1	.53	.53	1.62	.204
Error	234	76.75	.33		
Total	237	84.37	.36		

* = Significant at the <.05 level

Table 6. *ANOVA for Geometric Shape Identification (Treatment by Grade)*

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio	F Prob.
Treatment (A)	1	142.19	142.19	254.10	.000*
Grade Level (B)	1	10.42	10.42	18.62	.000*
Treatment X Grade (AB)	1	6.28	6.28	11.21	.001*
Error	234	130.95	.56		
Total	237	289.84	1.22		

* = Significant at the <.05 level

Based upon the observed performance and attitude of the students along with the changes in their ability to see geometric constructions within a piece of artwork, it appears that using Logo can be helpful in promoting visual-spatial awareness. This is particularly true at the sixth grade level. Even though the second graders were not able to create tessellations by building shapes from scratch on the computer, they did get the experience of creating the tessellations within Logo by using the shapes page and the SHADE command, so the end result was similar. They also were able to view the computer screens of their peers to discuss which ones tessellated and which ones did not.

Even these young students were able to improve their performance on the posttest. T-tests on the total group of second grade students revealed that second graders in the treatment group scored significantly better in recognizing both figures and geometrics shapes (see Table 7).

Table 7. *T-Test between Control and Treatment Groups of Second Grade Students*

Group	n	Mean	SD	SE	F Value	2-Tail Prob.
Figures						
Control	55	2.45	0.86	0.12	1.93	0.02
Treatment	48	2.71	0.62	0.09		
Geometric Shapes						
Control	55	0.18	0.51	0.06	3.97	0.00
Treatment	48	1.35	1.02	0.15		

Significant at the $<.05$ level

Students in this study seemed to have a positive attitude about this unit. While some students struggled with the assignments and were not able to complete the on-screen tessellations, others created Escher-like designs, thus accomplishing the overall objectives of the unit.

In this case the choice of teachers, the amount of weekly time spent in the computer lab and duration of this study were controlled by the school schedule. Although it is practical to conduct a study within the confines of the daily school routine this situation places limitations on the research. It would be helpful, for instance, to use the same teacher for both grades to eliminate teacher variability. Even though this study tried to control for teaching technique by scripting the lessons, one teacher did not adhere to the script and used a teaching style that told answers to the students rather than challenging the students to discover the answers. This makes it difficult to have absolute confidence in comparisons between the grade levels.

Although schools tend to focus on activities that use left brain or language processes more than right brain processes, many students do function very well, or even better, using the artistic element promoted by the right side of the brain. If Logo is valuable in aiding development of visual literacy, then it certainly can benefit students at the lower and upper elementary grade levels.

Further research should be conducted using this study as a pilot test. Such research would be most helpful if it encompassed a longer period of time for the activities in the unit, particularly at the second-grade level. The second graders probably need a full school year to accomplish the objective of learning to tessellate figures from scratch within the Logo language. A longitudinal study might also include the question of how the combination of computers and art over time affects students attitudes toward the visual arts.

REFERENCES

Arnheim, R. (1986). *New essays on the psychology of art.* Berkeley: University of California Press.

Arnheim, R. (1974). *Art and visual perception.* Berkeley: University of California Press.

Curtiss, D. (1987). *Introduction to visual literacy: a guide to the visual arts and communication.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Erikkson, G. (1988). Thinking in visual images in the information age -- the changing faces of the school. *Gifted Education International, 5*(1), 97-103.

Jones, E. (1989). *Reading the book of nature: a phenomenological study of creative expression in science and art.* Athens, OH: Ohio University Press.

Locher, J. L. (Ed.) (1988). *The world of M. C. Escher.* New York: Harry N. Abrams.

Knupfer, N. N. (1991). The effects of student ability grouping on transfer of knowledge and cognitive gains in a Logo environment. Paper presented at the annual meeting of the American Educational Research Association (AERA). Chicago, IL. April 3-7.

Sinatra, R. (1986). *Visual literacy connections to thinking, reading and writing.* Springfield, IL: Charles C. Thomas.

Thornburg, D. D. (1983). *Discovering Apple Logo: an invitation to the art and patterns of nature.* Reading, MA: Addison-Wesley.

Title:

The Significance of the Channel One Experiment: Report on the First Year

A SYMPOSIUM

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The Significance of the Channel One Experiment: Report on the First Year

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Channel One is a twelve minute video news magazine which is currently beamed by satellite to over 2000 high schools in the United States. Produced by Whittle Communications, the program attempts to bring current events to students while they are in the classrooms. The controversy surrounding the use of this program in schools stems primarily from the fact that two minutes of advertising are embedded in each twelve minute program. New York and California have banned the use of this program in the classroom on the grounds that Chris Whittle is selling student audiences to advertisers. (A serious challenge to the California ban is pending.) Without discounting the importance of "Sanctioned ads" in U.S. classroom, we would like to raise additional questions about the meaning of this innovation in school systems.

Concerns and questions abound in any discussion of the use of *Channel One* in our public schools. Many educators are concerned about the impact that such an innovation might have on the students and teachers, the curriculum, and the community itself. Parents are interested in their children having the best educational opportunities, but are questioning if this innovation represents the best.

This symposium is based on a research project which was completed during the first year of the program's broadcast. Six researchers with different areas of expertise investigated the impact of *Channel One* in varying aspects of schooling.

An expert in methods of empirical research conducted a study to measure student's retention and comprehension of current event facts; this research involved over 4000 students in various schools districts. In addition, a survey was administered to students and teachers at the beginning of the year and again after a year of viewing the program; the survey measured attitudes and opinions about the program.

A professor who conducts and teaches case study methodology directed a case study of *Channel One* at a participating site. The site chosen was a small district, with one high school and a junior high. Several teachers and students participated in in-depth interviews and the data was analyzed qualitatively. The report of the case study focuses on several aspects of the project, such as the diffusion of innovation in schools, the involvement of teachers in such innovation, and the effect of an innovation on curriculum and teaching practices. The implications of the project are many, ranging from policy about involvement of private sector in public education to reactions and observations of students and teachers.

Another researcher who has experience in policy issues examined the impact of *Channel One* on curricular issues. When any innovation causes so much debate, policy-makers and decision-makers need to reflect on possible implications of the innovation within schools.

An advertising professor and researcher will address the impact of *Channel One* advertising on the teen viewer. Much of the public news and debate about *Channel One* focuses on the advertising.

Another team member conducted a structural analysis of the program itself to ascertain what messages are being encoded in the production and how students are interpreting them. And, the final member of the research team coordinated the team's efforts.

Specific focus questions directed the research team as follows:

- Do students remember and comprehend current events after watching *Channel One*?
- Do students remember and comprehend commercial advertisements in *Channel One*?
- Does *Channel One* heighten student interest in current events?
- Does *Channel One* heighten student interest in products? advertised?
- In addition to current event information, what messages are embedded in the program?
- How are students interpreting embedded messages?
- What is the impact of *Channel One* on lesson planning?
- What is the impact of *Channel One* on curriculum development?
- For school boards, what are the implications of selling target school populations to advertisers in the private sector?
- What are the implications of private sector curriculum development for professional educators?
- What influenced your decision to use *Channel One*?
- How was the decision reached? Who helped make the decision?
- What was the initial teachers, student, and parent reaction?
- Who coordinates the use of the program?
- Have the teachers been helped in their use of the materials?
- How have students used the information?
- What has been the reaction of the participants?
- What will influence the success of this project?
- What advantages and disadvantages are seen?
- Will the project be continued?
- What other use of the equipment is made or planned?

- When is the program shown?
- How do students feel about the program?
- How do students and teachers feel about the commercials?
- What is the place of so called free and inexpensive materials in the classroom?
- What is the function of journalism in a free society?
- What is the responsibility of citizens in a democracy to fully inform themselves?
- Can the privatization of information and discourse ever be compatible with public discourse?
- Should impoverished school budgets limit teachers and learners to so called free sources of information?

Title:

An Assessment of Teacher Trainees' Attitudes Toward Selected Instructional Media

Author:

Franklin R. Koontz

Introduction

Life in the information age is predicted to be easier and more productive. The common use of modern technology, such as the use of robotics, electronic information retrieval and communication, as found in teleconferencing and electronic mail, and in voice and computer controlled simulated environments, will enable work to be completed more accurately and faster. Generally, those who can adapt and be trained to deal with this new technology will prosper. Those who cannot adapt and be trained will fall behind and become information deprived (Jonassen, 1984). Likewise, those teachers who are not trained in this new technology will not only fall behind and become information deprived, but their students will also be affected.

Power on! New Tools for Teaching and Learning, prepared by the United States Congress Office of Technology Assessment, purports that there is a willingness on the part of school districts, schools, teachers, and parents to explore the use of new learning technologies. Growth in use has been impressive and indications suggest that the future use of technology remains strong. However, present conditions still indicate that (1) the majority of schools do not have sufficient hardware, (2) students spend less than one hour per week using a computer, (3) poor and minority students have less access to technology, and (4) the vast majority of teachers have little or no training to use this technology (OTA, 1988).

Part of the focus on educational improvement lies with teacher training. It is the teacher who makes one of the critical decisions about instruction. Schools may change in the future, but it is how teachers view technology and their "preparation to use technology to instruct, manage and evaluate are critical to the better use of technology in the curriculum" (Glenn and Carrier, 1989).

At the university level, schools of education are currently being required to revise their preservice teacher education programs and include training in the use of technology in the classroom. There are approximately 1300 institutions in the United States that educate teachers and prepare them for licensure. While California has legislated that all teachers must complete a technology training component, other states are moving toward mandating technology training as part of the licensure process for beginning teachers (Glenn and Carrier, 1989). A 1979 Association of Educational Communications and Technology (1982) survey disclosed that 36 percent of the states had no media requirements in teacher education programs, while 64 percent of the states required limited media instruction. There were, however, four states, Louisiana, Ohio, Oregon, and Wyoming, that required media standards. In a 1989 survey, 18 states and the District of Columbia, required that all students in their teaching degree programs or those seeking certification take a course on computer topics or demonstrate familiarity in using technology for instruction. Yet half of the states neither require nor recommend technology preparation for new teachers (Fulton, 1989).

A survey conducted by the American Association of Colleges for Teacher Education asked faculty and students in 90 member institutions to evaluate the effectiveness of their teacher education programs in preparing classroom teachers. For most aspects of teaching, e.g., planning instruction, evaluating students' learning, using proper teaching methods, etc., the report was positive. More than two-thirds of education faculty and students considered graduates to be prepared to assume tasks of classroom teaching. In the preparation of using technology, however, the results were not as positive. Fewer than one-third of the students reported they thought they were prepared to teach using technology (Fulton, 1989).

There is a need to train teachers in the selection and utilization of instructional media in powerful ways to significantly enhance learning and thinking. The effective selection and use of instructional media in the classroom is a way to improve content mastery and student thinking skills. It also increases individualized instructional opportunities, improves student attitudes towards learning, and it prepares students for a technology-oriented society. Instructional media also can increase teachers' job justification and increase the cost-effectiveness of instruction (Boe, 1989).

Significance of Study

The assessment of attitudes of trained and untrained preservice and full-time teachers toward the selection and use of instructional media has been researched since 1959 (Kelly, 1959; Cole, 1964; Acquino, 1968; Wheller, 1969; Lasher, 1971; Jenkins, 1972; Welch, 1974; Long, 1974; Kreamer, 1978; Jones, 1982). The results of these studies have produced a mixture of findings. Kelly, Cole, Wheller, Jenkins and Long found that preservice teachers were positively influenced toward the selection and use of instructional media upon the completion of formal training. It was reported that formal training produced the necessary intellectual and motor skills to create a positive attitude toward the selection and utilization of instructional media. However, Acquino found that formal training in instructional media produced negative results, while Lasher, Kreamer, and, Jones concluded that formal training did not significantly change the attitude of the preservice teachers or full-time teachers toward the selection and utilization of instructional media. The researchers further concluded that there was no relationship between attitude and the amount of professional training. Welch concluded that the attitude of the teacher was not a major factor in determining the utilization of instructional media.

It can be concluded that previous studies have not produced definitive attitudinal trends. As technologies of instruction have become more advanced and sophisticated, especially with the advent and development of the microcomputer, there is a need to ascertain and describe the accumulated knowledge concerning the attitudes of preservice teachers toward the selection and use of instructional media for several reasons.

First, this study identified and verified attitudes associated with the selection and utilization of instructional media for classroom instruction. Second, this study presented a report of preservice teacher attitudes toward selected instructional media and materials which can be reviewed and studied by other researchers. Third, while research related to this study was conducted in the late 50s, 60s and 70s, enough time has elapsed and the learning environment in schools and the role of the teacher has changed sufficiently to warrant up-dating current preservice attitudinal trends toward the selection and use of instructional media. And fourth, this study provided the assessment of preservice teacher attitudes and the shift in attitudes toward instructional media as a result of formal training and student teaching, of which the established body of attitudes can be used as a basis for further attitudinal research and curricular changes. What preservice teachers use and select as instructional media when planning instruction during student teaching may be an indicator of what may be selected and used when teaching full-time.

It can be inferred that a positive attitude toward instructional media during formal training should result in the successful demonstration and application of instructional media when teaching full-time. To require preservice teachers to receive formal training in the selection and use of instructional media, however, may or may not appear to be the independent variable that will determine its use by the teacher in the classroom. There may be other factors that have an influence upon the preservice teacher's decision to adopt instructional media in the systematic approach to the design of instruction. Therefore, how preservice teachers rated instructional media and materials provided additional information about the selection and utilization of alternative instructional delivery systems used in the classroom.

Statement of the Problem

The nature of the learning environment and the role of the teacher has changed significantly since the Kelly study and other studies have been conducted. Improvements and changes in selected technology of instruction for classroom use have occurred. It was apparent that there was insufficient current research that accurately defined the present status of preservice teachers' attitudes or changes in attitudes toward the selecting, utilizing, and rating of instructional media after formal training or after student teaching.

Research Questions

Given the stated problem underlying this study, the following research questions were designed to address the problem:

1. What are the attitudes of preservice teachers toward the selection and use of instructional media prior to formal training?
2. Are there positive changes in attitudes toward the selection and use of instructional media in the classroom after having received formal training?
3. What are the attitudes toward the selection and use of instructional media prior to completing student teaching?
4. Are there positive changes in attitudes toward the use of instructional media after completing student teaching?
5. Are there differences in attitudes toward the selection and use of instructional media between preservice teachers completing formal training of instructional media and preservice teachers completing student teaching?
6. Are there differences in attitudes toward the selection and utilization of instructional media between those preservice teachers prior to formal training and preservice teachers completing their student teaching?
7. How would preservice teachers enrolled in a formal training course of instructional media and preservice teachers completing student teaching rate specific types of instructional media and materials?
8. To what extent was instructional media available to preservice teachers completing student teaching?
9. To what extend did the supervising teacher use instructional media in the classroom?
10. To what extent was instructional media used by preservice teachers during student teaching?

Hypotheses

The study was based upon the following hypotheses:

Ho1: Preservice teachers will have a more positive attitude toward the selection and use of instructional media after having received formal training in the selection and use of instructional media.

Ho2: Preservice teachers will have a more positive attitude toward the use of instructional media after having completed student teaching.

Ho3: There are no differences in attitudes toward the use of instructional media by preservice teachers taking a formal course in instructional media and preservice teachers completing student teaching.

Ho4: There are no differences in attitudes toward the selection and utilization of instructional media by preservice teachers prior to formal training and preservice teachers after completing student teaching.

Ho5: There are no differences in rating of media types and materials by preservice teachers enrolled in the selection and utilization of instructional media course and preservice teachers completing student teaching.

Survey of Literature

Learning psychologists advocate that learning should first come from direct experiences, second from the iconic representation of films, television programs, etc., and third from the symbolic experience of textbooks, lectures, etc. However, the symbolic representation is usually the first employed form of instruction which would include reading assignments, class discussions, teacher-directed presentations, question and answer sessions, etc. However, educational technologists would advocate that, ideally, the selection and utilization of instructional media should be employed as the learning transitional mechanism between the direct and symbolic experience prior to the symbolic stage.

Previous research has indicated that students learn from the use of instructional media incorporated into a well written lesson plan. Benefits from using instructional media include a vicarious learning experience, precise communication, increased interest in learning by the student, and increased options for learning.

When conducting research, the measurement of attitudes is difficult. Measuring a change in attitude requires using even a more complex procedure. Attitudes are dynamic due to the amount of outside stimuli constantly impacting upon the complexity of the attitude itself. To measure an attitude, the object of the attitude must have a precise definition, and the attitude must be observable. At best, the researcher relies upon an inference of the attitude since it is impossible to directly measure the attitude due its complexity. It is also important for the researcher, in an attitudinal survey, to measure and report the attitudes of the group and not the attitudes held by the individual subject.

To further complicate attitudinal research, there is no consensus among social scientists as to the definition of attitude. For this research study, Mueller's (1986) definition was adopted. The attitudinal object for this study was instructional media.

It was observed that several previous studies indicated that a positive attitude toward the selection and utilization of instructional media would result in increased use. This would support the common notion that a positive attitude produces a particular behavior. The survey of literature disclosed that attitudes do not determine particular behaviors. Attitudes, however, make certain behaviors more or less probable (Gagne, 1985). Attitudes can be described as response tendencies or the readiness to respond. The researcher cannot predict that a positive attitude toward the selection and utilization of instructional media will result in the actual selection of instructional media. The researcher should infer that there is a greater likelihood that preservice teachers will select and use instructional media after formal training and student teaching has been completed.

The survey of literature found that positive and negative attitudes were produced by formal training in the selection and utilization of instructional media. Kelly (1959), Cole (1964), Wheller (1969), Jenkins (1972), and Long (1976), found that preservice teachers were positively influenced toward the selection and use of instructional media upon the completion of formal training. Formal training produced the necessary intellectual and motor skills to create a positive attitude toward the selection and utilization of instructional media. However, Aquino (1968) found that formal training in instructional media produced negative results, while Lasher (1971), Kreamer (1978), and Jones (1982), concluded that formal training did not significantly change the attitude of the preservice teachers or full-time teachers toward the selection and utilization of instructional media. It was also concluded that there was no relationship between attitude and the amount of professional training.

The literature revealed there were several additional variables that could influence the selection and use of instructional media:

1. The presence of a full-time audiovisual coordinator, i.e., a school media specialist, formally trained in the selection and utilization of instructional media, would create a positive instructional media climate (Miller, 1969).

2. There is a positive relationship between the attitude of teachers and the support received from the administration (Kelly, 1959, Gray, 1971).

3. The value of the medium of instruction does not necessarily lie within the medium itself, but how it is perceived by the teacher and students (Dodge, et al., 1974).

4. Teachers are affected by how instructional media may be defined; traditional or innovative. Teachers held more positive attitudes toward traditional media than innovative media (Bish, 1967).

5. Teachers will display a negative attitude toward instructional media if they believe that it will replace them in the classroom (Everson, et al., 1978).

6. Teachers will display a negative attitude toward instructional media if it is described as technology (Everson, et al., 1978).

7. The attitude of the teacher is not the major factor in determining the selection and utilization of instructional media. An innovative curriculum is a better predictor of the selection and utilization of innovative instructional media; a traditional curriculum is a better predictor of the selection and utilization of traditional media (Seidman, 1986).

8. There is no relationship between subject area taught and the use of instructional media (Kelly, 1959, Jenkins, 1972).

9. There is no relationship between grade level and the use of instructional media (Jones, 1982).

10. The attitude of the teacher toward instructional media is not affected by a lapse of time when the teacher is formally trained in the selection and use of instructional media and when it is used (Aquino, 1974).

11. There is a positive relationship between the amount of teaching experience, the amount of media used, and the amount of professional training (Lasher, 1971).

12. Failure to deal with the negative attitude that instructional media will replace the teacher, may have a negative affect upon the teachers' attitudes (Everson, et al., 1978).

Methodology

This quantitative, descriptive research study measured the attitudes of preservice teachers toward the selection and use of instructional media at two levels of teacher training: preservice teachers enrolled in formal training of the selection and utilization of instructional media, and preservice teachers completing their student teaching requirement.

The nature of the learning environment and the role of the teacher have changed significantly since the Kelly study and other studies have been conducted. Improvements and changes in selected technology of instruction for the classroom use have occurred. Insufficient current research existed that accurately defined the present status of preservice teachers' attitudes or changes in attitudes toward the selection, utilization, and rating of instructional media after formal training or after student teaching.

Subjects

This study was limited to those students enrolled in the preservice teacher certification course, Introduction to Instructional Media, 310:201, at The University of Toledo, constituting the formal training group. The second group were those students completing their student teaching requirement for certification during Winter Quarter, 1991.

There were approximately 168 preservice students enrolled in the Introduction to Instructional Media course and approximately 170 student teachers completing their student teaching requirement during the 1991 winter quarter.

Instrumentation

Preassessment Instrument. An instrument was designed to obtain demographic data about the subjects enrolled in the formal training course, Introduction to Instructional Media, 310:201. The background information obtained from the subjects included gender, age, the grade level which the preservice teacher would teach, grade point average (GPA), and class rank. Part 1 of this self-reporting instrument obtained data that concerned the selection of media, degree of skill, and frequency of use. Part 2 dealt with the production of instructional materials, the degree of skill, and frequency of use. Part 3 was concerned with the use of systematic instructional design techniques, the degree of skill, and frequency of use. The purpose of this data was to increase external validity. This data served as a descriptive profile of the subjects involved in formal training of instructional media for this study (see Appendix A).

Attitude Instrument. A survey instrument was designed to ascertain the attitudes of preservice teachers enrolled in formal training and preservice teachers completing their student teaching.

The process of designing the attitude survey instrument first involved reviewing existing literature that contained surveys that assessed attitudes toward the use of instructional media. Several attitude surveys were reviewed, including Paul Dawson's Media Attitude Profile (Long, 1976), and a fifty-seven item survey and the modified version of this Media Attitude Profile (MAP) survey designed by Kreamer (1978). A third attitude survey, designed by Chi-Yin Ywen, was also examined (DelFrate, 1987). Second, areas of research interest were established. These areas included: (1) the contribution that media can make to instruction; (2) the positive attributes of instructional media; (3) the future use of instructional media; (4) taking a required course in instructional media; (5) present perception toward teaching with instructional media, (6) the conditions of using instructional media, (7) course-specific perceptions, and (8) perceptions toward systematic lesson planning techniques. The third step included the writing of specific response items. When the response items were written, the guidelines of the behavioral-tendency response items of *would* and *should.* were taken into consideration. *Would* items (Mueller, 1986) express a personal behavior intention toward the attitudinal object. *Should* items express a behavioral preference for social action. As a general rule, "items inquiring about respondents' actual behaviors should be omitted" (Mueller). Therefore, the response items included the term *should.*

The collection process. This study used the self-report method,i.e., the subjects were given an attitude survey instrument and were requested to report their own attitudes concerning each of the response items. This type of data collection procedure represents the most direct type of assessment (Henerson, Morris and Fitz-Gibbon, 1987).

The attitude survey instrument was reviewed by a panel of judges and changes were made upon recommendations. The survey instrument was tested during Fall Quarter, 1990 with subjects enrolled in the Introduction to Instructional Media course, 310:201. Further modifications were made based upon the results obtained

Semantic differential. The survey of literature also revealed another form of media evaluation in the form of a semantic differential, as was used by Elliott, et al., (1984). The purpose of using this semantic differential was to obtain the ratings of various types of media and materials used in Module 1, 2 and 3 for the Introduction to Instructional Media course as well as those preservice teachers completing student teaching. This semantic differential offered the respondents sets of bipolar adjectives with a seven-point scale separating each set (Bellamy, et al., 1978). The respondents were asked to mark the scale point which most nearly represented their attitudes. The mean score across the groups of respondents provided data which served to establish a base line for selection and use trends by the subjects. Two forms of the semantic differential were administered. The first instrument was administered to the students enrolled in the formal training group which contained four sets of bipolar adjectives. The second form of the semantic differential was administered to the student teachers. This instrument had an additional set of bipolar adjectives and obtained data concerning whether the media were available or not available during student teaching.

Student teacher utilization profile. To obtain data concerning the selection and use of instructional media while the preservice teachers were completing the student teaching, a student teacher media utilization profile instrument was designed in a similar format as that used by Welch (1974). The purpose of this instrument was to establish the types and amount of media that were used by the preservice teacher when completing student teaching

Method of analysis

The pretest - posttest nonequivalent control group design was used to analyze the attitude survey for the first hypothesis (Wiersma, 1986), i.e., preservice teachers have more positive attitudes toward the selection and use of instructional media after having received formal training in the selection and use of instructional media. The same procedure was used to analyze the second hypothesis, i.e., preservice teachers have more positive attitudes toward the use of instructional media after having completed student teaching. A polled difference in gain scores from the pretest and posttest attitude scores was measured by using a *t* -test, two sample dependent means at the .05 level of significance (Hinkle, Wiersma, and Jurs, 1988), where:

$$\text{Ho: } \partial = \mu 1 - \mu 2 = 0 \text{ and Ha: } \partial = \mu 1 - \mu 2 \neq 0.$$

This statistical procedure determined if there was a significant difference in attitude toward the selection and use of instructional media from the beginning of the formal training course to the end of the formal training. Both preservice intact groups received the attitude survey.

A postest nonequivalent control group design was used to test the third, fourth, and fifth hypotheses: (Ho3) there are no differences in attitudes toward the use of instructional media by preservice teachers taking a formal course in instructional media and preservice teachers completing student teaching; (Ho4) there are no differences in attitudes toward the selection and utilization of instructional media by preservice teachers prior to formal training and preservice teachers completing student teaching; and, (Ho5) there are no differences in ratings of media types and materials by preservice teachers enrolled in formal training and preservice teachers completing their student teaching. Pooled difference in scores were measured by using a *t*-test, two sample case, and independent means, where:

$$\text{Ho: } \mu 1 = \mu 2 \text{ and Ha: } \mu 1 \neq \mu 2.$$

The statistical package SPSS-X was used to calculate the results (SPSS-X User's Guide, 1988).

To analyze the extent to which instructional media were available to preservice teachers while completing student teaching, survey data was compiled from the media rating instrument and the central tendency was determined.

To analyze the extent to which instructional media were used by preservice teachers and their supervising teachers while completing student teaching, the data was obtained from the Student and Teacher Utilization Profile and central tendency was determined. The statistical package SPSS-X was used to calculate the central tendency results for both sets of data.

Summary, Discussion, Conclusion, Implications, and Recommendations for Further Study

Summary

This study measured the attitudes of preservice teachers toward the selection and utilization of instructional media used in the classroom. Two groups of preservice teachers were involved in the study. The first group were subjects enrolled in a formal training course in the selection and utilization of instructional media. The second group of subjects were preservice teachers completing student teaching and had already completed a formal training course in the selection and utilization of instructional media.

An attitude survey was developed that contained eight specific categories to measure the subjects' degree of agreement toward the selection and utilization of instructional media. These categories included: (1) the contribution media can make to instruction; (2) the positive attributes of instructional media; (3) the future use of instructional media; (4) taking a required course in instructional media; (5) present perception toward teaching with instructional media; (6) the conditions of using instructional media; (7) course specific perceptions; and, (8) perceptions toward systematic lesson planning techniques.

The study was based upon five hypotheses which were supported by research questions:

Ho1: Preservice teachers have a more positive attitude toward the selection and use of instructional media after having received formal training in the selection and use of instructional media.

Ho2: Preservice teachers have a more positive attitude toward the use of instructional media after having completed student teaching.

Ho3: There are no differences in attitudes toward the use of instructional media by preservice teachers taking a formal course in instructional media and preservice teachers completing student teaching.

Ho4: There are no differences in attitudes toward the selection and utilization of instructional media by preservice teachers prior to formal training and preservice teachers completing student teaching.

Ho5: There are no differences in rating of media types and materials by preservice teachers completing formal training of instructional media and preservice teachers completing student teaching.

This study also provided demographic data concerning the type of subject enrolled in formal training of instructional media. The data disclosed that the majority of students were sophomores (58.6%) and juniors (22.8%) with the remainder of the students (18.7%) were freshmen, seniors, and undergraduates with degrees. The subjects had a combined mean grade point average of 2.83 on a 4.0 scale. The majority of students reported their preferred teaching level was elementary school (40.6%) and senior high school (28.7%). The remainder of the students indicated special education (16.8%), junior high school (4.9%) and K-12 (2.8%).

The preassessment survey concerning the amount of skill and use of instructional media, producing instructional materials, and lesson planning techniques, indicated that the subjects had limited or no skills. The frequency of use of instructional media, instructional materials, and lesson planning techniques also disclosed that the subjects' use ranged from occasionally to seldom used. Therefore, the preassessment profile indicated that the subjects enrolled in formal training of instructional media began the course with no skills nor having used the selected media, materials, or formal lesson planning techniques.

Also provided in this study was the amount of media used by student teachers and their supervising teachers. This data was obtained using a Student and Teacher Media Utilization Profile.

Discussion

Hypothesis 1: The pretest-posttest for Hypothesis 1, preservice teachers have a more positive attitude toward the selection and use of instructional media after having received formal training, revealed 21 significant differences and four (4) nonsignificant differences. The hypothesis was retained.

The following discussion is an analysis of the attitude survey by objective category.

Category 1: The contributions of instructional media. The formal training group strongly agreed that instructional media can present accurate information, can create interest and options for learning, and provide a vicarious learning experience.

Category 2: The positive attributes of instructional media. The subjects strongly agreed that a teacher should be at ease using instructional media. The subjects agreed that instructional media is just another way to teach and that instructional media was as good as, if not better than, traditional forms of teaching. The subjects were undecided or uncertain that nonprint media, such as film, a television lesson, etc., can provide all the necessary information for learning.

Category 3: The future use of instructional media. The subjects strongly agreed that when they are teaching they intended to use instructional media. The subjects agreed that a beginning teacher should incorporate instructional media into lesson plans.

Category 4: Taking a required course in instructional media. The subjects strongly agreed that a teacher should know how to use a variety of instructional media and agreed that a teacher should be required to take a course to learn how to use instructional media.

Category 5: Present attitudes toward teaching with instructional media. The subjects in all five survey items had a significant difference at the .0001 level. The subjects agreed that: (1) a highly motivated teacher uses instructional media when teaching; (2) when instructional media is used the teacher is using acceptable teaching strategies; (3) instructional media is a strategy employed by effective teachers; (4) using instructional media increases student learning; and (5) teachers who plan lessons that are learner centered use instructional media.

Category 6: Conditions of using instructional media. The subjects agreed that a teacher should use instructional media whether they are rewarded or not. The subjects were undecided as to whether or not instructional media should be used when needed, otherwise, traditional methods should be used. There was also no significant difference for this survey item.

Category 7: Course specific attitudes. The subjects strongly agreed to all items in this category although there was no significant difference for survey item 1, i.e., to be effective, a teacher needs to know how to produce instructional media properly. The subjects strongly agreed that: (1) a teacher should know how to properly use instructional media; (2) effective teachers should be computer literate; and, (3) to be effective, a teacher ought to know how to use instructional media properly.

Category 8. Systematic lesson planning techniques. The subjects were in agreement to both items, i.e., effective teaching requires systematic lesson planning, and systematic lesson planning is necessary for any teaching.

Hypothesis 2: The pretest-posttest for Hypothesis 2, preservice teachers have a more positive attitude toward the use of instructional media after having completed student teaching, yielded 24 no significant differences and 1 significant difference. The hypothesis was rejected. The attitudes of the students, once having been formally trained in the principles of selection and utilization of instructional media, were maintained after student teaching.

Hypothesis 3: The posttest scores concerning Hypothesis 3, there are no differences in attitudes toward the use of instructional media by preservice teachers after taking a formal course in instructional media and preservice teachers completing student teaching, revealed 21 no significant differences and 4 significant differences. The hypothesis was retained.

Hypothesis 4: The attitude survey prettest for the formal training group and the attitude survey posttest for the student teachers, for hypothesis 4, indicated no differences in attitudes toward the selection and utilization of instructional media by preservice teachers prior to formal training and preservice teachers completing student teaching, revealed 17 significant differences in attitude and 8 no significant differences. The hypothesis was rejected.

Hypothesis 5: There are no differences in the rating of media types and materials by preservice teachers enrolled in formal training of instructional media and preservice teachers completing student teaching. The comparison between the rating of media by the formal training group and student teachers in hypothesis 5 revealed no significant differences. The hypothesis was retained.

Conclusion

From the discussed results of this study, the following generalizations can be made and serve as the conclusion.

1. This study adds a new segment to the literature indicating that undergraduates entering a teacher training program do not have developed skills in the selection and utilization of instructional media.
2. This study refutes previous research that concluded formal training in instructional media had either no effect or a negative effect on the attitudes of the subjects. This study has demonstrated that the intervention of a formal course in the selection and utilization of instructional media can function as a primary factor in the development of students' attitudes in a positive direction.
3. Students in a teacher training program who have developed a positive attitude toward the selection and utilization of instructional media after formal training will complete student teaching with as much of a positive attitude, or even stronger positive attitude.
4. Of the ten media rated, this study indicates the most frequently used media during student teaching were the personal computer, overhead projector, and television.
5. Based upon all the results of this study, a developed positive attitude toward the selection and utilization of instructional media is related to the positive affect toward the practice of systematic lesson planning by teachers.
6. The instrumentation used in this study was effective in assessing the attitudes of the subjects toward the selection and utilization of instructional media. Moreover, the rating of instructional media led to outcomes that were different than those reported in some of the reviewed literature.

Implications

Given the results of this study concerning the attitudes of preservice teachers toward the selection and utilization of instructional media, it is in the judgment of the author, there are several implications that may be offered in the areas of teacher training, and at both the state and national levels.

Teacher training. Preservice teachers who have acquired, through formal training, a positive attitude toward the selection and utilization of instructional media are more likely to use instructional media in their classrooms when they teach. This finding is due to the development of selection and utilization skills that have been acquired during formal training. Conversely, there is a high probability that those teachers not having been trained in the selection and utilization of instructional media may possess negative attitudes toward its selection and may not use instructional media in their classroom. This lack of skill will negatively affect both the teacher and the students. It is important that a positive attitude toward instructional media be formed early in the preservice teacher training program. This will promote the selection and utilization of instructional media when teaching full time. A formal training course in the principles of selection and utilization of instructional media can shift the attitude of preservice teachers in a more positive direction. Formal training may be a factor in shaping attitudes.

The instructional design of course content and the presentation of course content in a formal training course in the selection and utilization of instructional media should be evaluated to determine the attitudinal effect upon preservice teachers.

It appears that once a positive attitude toward the selection and utilization of instructional media has been formed during a formal training experience, this positive attitude will be maintained throughout student teaching. The lapse of time between formal training and student teaching does not alter the attitude but reinforces the positive attitude.

If formal training is a factor in shaping a positive attitude toward the selection and utilization of instructional media, it would be appropriate to have all faculty and administrators who are involved in the teacher training program to receive similar training and for faculty to be encouraged to use instructional media in their teaching. This would reinforce the contribution of media to instruction and would also provide positive role models for students who are enrolled in the teacher training program to emulate.

State level. The findings of this study should be presented at the state level to the appropriate educational bodies, such as the State Department of Education or the Board of Regents. Policy makers at that level should consider adopting a standardized formal course of study in the selection and utilization of instructional media. In addition, the decision makers should be encouraged to financially support such an adoption by allocating funds to equip the teacher training institutions with the software and hardware necessary for proper instruction. Furthermore, the policy leaders should be encouraged to allocate funds for school districts to purchase needed software and hardware that will enable the proper selection and utilization of mediated instruction in the classroom.

National level. The findings of this study need to be shared with various professional organizations, such as The Association of Educational Communication and Technology (AECT), and The Association for Supervision and Curriculum Development (ASCD), etc. In addition to formal presentations offered to the constituency, the promotion for and the adoption of formal course offerings in the selection and utilization of instructional media at all teacher training programs should be discussed and considered.

Recommendations for Further Study

Based on the analysis of the results of this study, the following recommendations are proposed for future research:

1. This study should be replicated, with larger samples, in other preservice teacher training programs to determine the attitudes of the preservice teacher toward the selection and utilization of instructional media.

2. A longitudinal study should be conducted, using the same or similar instruments contained in this study, of teachers who have previously received formal training in instructional media and who are in their third to fifth year of teaching, to determine their attitudes toward the selection and utilization of instructional media.

3. States that do not require formal training in the selection and utilization of instructional media should replicate this study with various preservice

teacher training programs to determine the present attitude of preservice teachers toward the selection and utilization of instructional media.

4. A study should be conducted to determine the extent to which media are being selected and utilized by teachers who have been formally trained, and teachers who have not been formally trained, in the selection and utilization of instructional media.

5. Research should be conducted to study the attitudes of experienced teachers toward instructional media and determine if their attitudes are related to the content of their teacher preparation programs.

6. Research should be conducted to determine if there is a relationship between course design and the selection and utilization of instructional media, i.e., does course design influence attitudes toward the selection and utilization of instructional media?

7. Studies should also be conducted to determine if there is a relationship between the presentation of a course and the attitude toward the selection and utilization of instructional media, i.e., does the way a course is taught affect attitudes toward the selection and utilization of instructional media?

8. Further research on barriers to the adoption of the selection and utilization of instructional media should be conducted.

9. A study should be conducted, at the professional level, to determine the effects of inservice training on those teachers who have previously received formal training in the selection and utilization of instructional media.

In summary, course experience related to formal training in the selection and utilization of instructional media does produce a positive attitude toward the use of technology in the classroom. Once the positive attitude has been developed it is not altered by student teaching.

Bibliography

Aquino, C. C. (1968). A study to determine the attitudes of educators following the study of audiovisual education. Dissertation Abstracts International, 30, 182A.

Aquino, C. C. (1974). Teacher attitudes to media teaching environments. British Journal of Educational Technology, 5, 72 - 79.

Association of Educational Communications and Technology. (1982). A survey of media instruction in undergraduate teacher education. Instructional Innovator, September, 32-34.

Bish, J.C. (1967). A study of teachers' attitudes toward selected technological media of instruction and an examination of salient variables related to these attitudes. Dissertation Abstracts International, 28, 3354A.

Boe, T. (1989). The next step for educators and technology industry: Investing in teachers. Educational Technology, March, 39-44.

Cole, J. H. (1964). Effects of an audiovisual course on prospective teachers' attitudes toward the use of audiovisual materials and toward teaching. Dissertation Abstracts International, 25, 5762 - 5763A.

Day, J. & Schoal, P. (1987). Media attitudes of teachers can be changed. Educational Technology, 23, (1), 23-25.

DelFrate, J. (1987). An investigation of teachers' backgrounds, usage, and attitudes towards computers in education.(Doctoral dissertation, The Ohio State University). Dissertation Abstracts International, 49, DA8804029.

Dodge, M. Bogdan, R., Brogden, N., & Lewis, R. (1974). How teachers perceive media. Educational Technology, 14 (1), 21-23.

Elliott, P.G., Ingersoll, G.M., & Smith, C.B. (1984). Trends and attitudes in the use of educational media and materials. Educational Technology, 24, (4), 19-24.

Everson, H. & Tobias, S. (1978) Fear of automation in teachers' attitudes toward instructional media. Paper presented at the Annual Meeting, American Educational Research Association, Toronto, Canada. (ERIC Document Reproduction Service No. ED 151 314)

Fulton, K. (1989) Technology training for teachers: A federal perspective. Educational Technology, 24 (3), 12-17.

Gagne, R. (1985). The conditions of learning and theory of instruction. (4th ed.). New York: Holt, Rinehart and Winston.

Gagné, R., Briggs, L. & Wager, W. (1988). Principles of instructional design (3rd ed.) New York: Holt, Rinehart and Winston, Inc.

Glenn, A.D., & Carrier, C. A. (1989) A perspective on teaching technology training. Educational Technology, March, 7-11.

Gray, R.A. (1971). Factors influencing high school principals' attitudes toward educational media. Dissertation Abstracts International. 32, 4326A.

Heinich, R., Molenda, M. & Russell, J. (1989). Instructional media and the new technologies of instruction. (3rd ed.). New York: Macmillan Publishing Co.

Henerson, M. Morris, L. & Fitz-Gibbons, C. (1987). How to measure attitudes. Newbury Park: Sage Publications.

Hinkle, D., Wiersma, W. & Jurs, S. (1988) Applied statistics for the behavioral sciences. Boston: Houghton Mifflin Company.

Jenkins, D.M. (1972). An investigation of teacher attitudes toward educational media when related to a basic course in educational media. Dissertation Abstracts International, 33, 1564A.

Jonassen, D. (1984). The mediation of experience and educational technology: A philosophical analysis. Educational Communications and Technology Journal, 3, 153-167.

Jones, G. N. (1982). The relationship of media training and media use by student teachers and first year teachers. Unpublished doctoral dissertation. The University of Toledo.

Kelly, G.B. (1959). An analysis of teacher attitudes toward the use of audiovisual materials. Unpublished doctoral dissertation. Boston University.

Knowlton, J. & Hawes, E. (1962). Attitude: Helpful predictor of audiovisual usage? Audiovisual Communication Review, 3, (10), 147 - 157.

Koontz, F. R. (1990). Media and technology in the classroom: Student workbook. Dubuque: Kendall/Hunt Publishing Co.

Kreamer, J.T. (1978). Attitude changes toward educational media of undergraduate students. Dissertation abstracts International, 39, 4668A.

Lasher, E.B. (1971). Educational media attitudes of and competencies for elementary teachers. Dissertation Abstracts International, 30, 182A.

Long, H.L. (1976). An analysis of selected first-year teachers' attitudes toward the use of audiovisual materials. (Doctoral dissertation, The University of Alabama). Dissertation Abstracts International, 77, 12265.

Miller, P.D. (1969). The relationship of teacher perceptions of a school's audiovisual climate to the organizational structure of its media program. Dissertation Abstracts International, 31, 564A.

Mueller, D. (1986). Measuring social attitudes: A handbook for researchers and practitioners. New York: Teachers College Press.

Nelson, C.E., Prosser, T., & Tuker, D. (1987). The decline of traditional media and materials in the classroom. Educational Technology, 14 (1), 48 - 49.

Patterson, A. (1980). Instructional development procedures and practices in selected training and human resources development programs. (Doctoral dissertation, Indiana University). Dissertation Abstracts International, (DDJ80-22715), 41-04A, p. 1345.

Seidman, S. A. (1986). A survey of school teachers' utilization of media. Educational Technology, 14 (10), 19 - 22.

Shorey, M. & Evans, A. (1988). Preparing educators with essential media competencies. Columbus: Higher Education Division, Ohio Educational Library/Media Association.

SPSSX-X user's guide. (3rd ed.) (1988). Chicago: SPSS, Inc.

Teague, F., Streit, L., Rogers, W. & Tipling, R. (1989). Media and technology in the classroom. Dubuque: Kendall/Hunt Publishing Co.

United States Congress Office of Technology Assessment. (1988). Power on: New tools for teaching and learning. Washington, D.C.: U.S. Government Printing Office.

Welch, F. (1974). Relationships between curriculum variables, attitudes, teacher characteristics and the utilization of instructional media (Doctoral dissertation, University of Southern California). Dissertation Abstracts International, 35, 5795A.

Wheeler, M.F. (1969). A study of relationships among professional attitudes, personal traits, and attitudinal change during instruction in perceptual media. Dissertation Abstracts International, 30, 2391A.

Wiersma, W. (1986). Research methods in education: an introduction. Boston: Allyn and Bacon, Inc.

Title:

Effects of Learning Style in a Hypermedia Instructional System

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EFFECTS OF LEARNING STYLE IN A HYPERMEDIA INSTRUCTIONAL SYSTEM

by

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Background

The development of hypermedia technologies has led to a great anticipation of applications in education. A hypermedia system can (1) support fast navigation and linkage of related information for associative learning, (2) represent multimedia elaborated information of various forms, (3) update information easily, and (4) provide a high degree of freedom for learners to select and to sequence information. However, current interest in the educational possibilities of hypermedia has focused mainly on the systems implementation and software development. Little attention has been paid to the complexity of the interaction of design strategies and learners' characteristics in the educational applications of these capabilities.

The most often mentioned capability of hypermedia systems is the provision of a high level of freedom for learners to navigate, to select, and to link related information of different forms. To accomplish these browsing, selecting, and linking processes in order to view related information, users usually have to point the mouse or any other input device on the marked text or a graphical icon called button and click on it; then the related information will be shown. The underlying assumption is that learners will actively choose to see more related information to form a knowledge base on a topic. Additionally learners will make use of the related information in conjunction with their own previous knowledge to enrich their knowledge base. This assumption requires further study. When learning in a hypermedia system, will learners actively use linking capabilities to seek related information or passively accept whatever they are given? If learners act differently, what factors contribute to the learning style variations? Will the frequency of interactivity decrease as the instructional time increases?

Research Questions

The study was conducted to answer the following questions regarding learning in hypermedia instructional systems.

1. Are there differences among subjects of different learning styles on:
    a. performance tests scores?
    b. time on task?
    c. selection frequency in viewing embedded elaborated information?
    d. attitudes toward the hypermedia system?
    e. acceptance of instructional advisement?

2. What effect does instructional strategy have on subjects of different learning styles on:
    a. performance tests scores?
    b. time on task?
    c. selection frequency in viewing embedded elaborated information?
    d. attitudes toward the hypermedia system?

3. Are there interaction effects of learning style and instructional strategy on:
    a. performance tests scores?

b. time on task?
c. selection frequency in viewing embedded elaborated information?
d. attitudes toward the hypermedia system?

Methods

This study was conducted to test the effect of learning styles and instructional advisement on subjects' achievement test performance, frequency in viewing embedded information, time on task, and frequency in receiving instructional advisement in a hypermedia instructional system. A survey on subjects' attitudes toward the instruction and the hypermedia system was conducted after the experiment was completed.

This was a two-session study with three weeks interval in between sessions. In Session One, a screening test on DNA and protein synthesis was administered to participants in order to assess their knowledge on the instructional topic to be covered. Participants who performed 80% or above mastery level on the topic were eliminated from the subsequent study. A learning style test was also administered to participants in the first session of the study in order to determine the group assignment. In Session Two, subjects were taught the topic using a hypermedia instructional program; then an achievement test was administered. A survey of their attitudes toward hypermedia and the subject matter also was conducted after they had finished the achievement test.

The learning styles of interest in this study were (1) passive, (2) neutral,and (3) active approaches toward learning which was determined by performance on the Passive Active Learning Scale Test (PALS), a 32-item inventory which was constructed for this study by the experimenter to measure learning characteristics of different learners.

The instructional strategy implemented in this study was (1) with and (2) without advisement at the end of each instructional segment. For those subjects who received the advisory version treatment, the instructional program monitored their interaction with the subject matter along the instructional segments and provided advisement to view key information at the end of each segment, if needed. The other treatment did not provide for any advisement, and served as control condition.

The experiment was a posttest-only control group design. Two experimental variables were arranged in a 3 x 2 factorial design. The first independent variable, type of learning style, consisted of (1) active-learning style, (2) neutral-learning style, and (3) passive-learning style. The second independent variable, instructional strategy, consisted of (1) advisory instructional strategy (experimental) and (2) nonadvisory instructional strategy (control). The five categories of dependent variables were (1) performance tests scores, (2) time on task, (3) selection frequency in viewing embedded elaborated information, (4) attitudes toward the hypermedia system and the instructional material, and (5) frequency of receiving instructional advisement.

Results

The results of this study indicated that achievement test scores, time on task, and selection frequency in viewing embedded elaborated information were affected by the interaction of learning style and instructional strategy for neutral-learning subjects. Those who received the advisory version performed better, spent more time on task, and chose to view more embedded elaborated information than neutral-learning subjects who received the nonadvisory version. Passive-learning subjects who received the advisory version scored significantly higher on their achievement test than passive-learning subjects who had the nonadvisory version.

The results of comparisons between active-learning and passive-learning subjects found there were significant group differences in the dependent variables of overall time on task and selection frequency in viewing embedded elaborated information, with active learners spending more time on task and choosing to view embedded elaborated information more often than passive learners. There was a trend toward a difference between these two groups in achievement test scores, with the active-learning group scoring higher.

Educational Implications

The results of this study indicated that learning style is a factor when the instruction is presented with a hypermedia system. This finding suggests the following practical applications in education:

1. Teachers should be encouraged to assess learning styles of their students in order to design instructional strategies for optimal learning,

2. The design and development of hypermedia programs should consider a student's learning style and be flexible. Instructional programs should be easily manipulated for presentation of material. With today's technology and computer hardware, these capabilities are within reach for educators to utilize for their students.

Title:

Advancing Distance Education Programs with Ordinary Technologies

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ADVANCING DISTANCE EDUCATION PROGRAMS WITH ORDINARY TECHNOLOGIES

The use of ordinary, relatively low-cost, and readily accessible technologies provides administrators, designers and faculty efficient communication tools for distance education. Voice mail, computer conferencing, audio conferencing, and locally produced video can enhance the quality and speed the rate of communication for distant learners and faculty. The latest, exotic and, quite often, most expensive technologies are the focus of most conference presentations, professional publications, and the popular press as they represent future, and often increased, capabilities for distance education. Course design and administration benefits from a combination of both kinds of technologies and this paper focuses on the use of ordinary information technologies.

Communication or information technology has been at the center of discussion of distance education from the earliest correspondence courses to the present use of satellite communication. Ease of use, speed and access are crucial in the design and administration of instruction. The provision of access to courses for those who are not served by campus-based instruction is the traditional role of distance education. The efficient execution of this role is affected by the speed of communication; increasing the rate of transmission has been the goal of many in distance education so that students and faculty can carry on a dialogue about the course subject matter.

Increasingly, access to education for those who do not attend classes on campus can be a question of their access to technology. The higher - or at least the more exotic - the technology, the fewer the students who have a means to use it. The postal service provides access for almost all students in the form of a postal address, making the U. S. Mail a universal and inexpensive medium of communication. It is a medium that can be used without traveling from home, without the purchase of exotic equipment, and without the need to learn how to use new technologies. Students have access and know how to use this technology, and almost all forms of distance education use printed materials relying on the postal service for the exchange of messages.

Speed, on the other hand, is not the postal service's major asset. Two weeks is a common time frame for the submission of written work, its grading, and the return of it with the instructor's comments. Two way live audio and video television communication, with facsimile or computer file transfer for written work, is obviously a more immediate communication system. While speed is its asset, its liability is its limited access because it currently requires students leaving their home, the procurement of televisions and other equipment, and user training for staff and students. Increasingly, distance education units are making the investment in the fastest and latest technology which gives them speed, but it sometimes costs them accessibility. While innovation in the use of the newest of technologies should continue, a parallel move to use existing and less expensive technologies can complement a distance education unit's communications plan.

This paper reports on Northern Virginia Community College, Extended Learning Institute's (ELI) use of low-cost technology as an example of these parallel communication plans. In particular, it examines the use of computer conferencing, voice mail, audio conferencing, and locally-produced video. With a base of 85 courses and 45 faculty, ELI has made many attempts in its 15 years to improve communication with its 3000 students. At present it uses cable and broadcast television, audio conferencing, audio and video tape, print materials sent via the post office, computer conferencing, fax, a compressed video network connecting its five campuses, telephone, and voice mail to communicate with students on administrative and instructional issues.

COMPUTER CONFERENCING

Computer conferencing is a relatively inexpensive technology and student access to it is increasing. Asynchronous (not real time) computer conferencing can be an important distance education medium in that it provides excellent "broadcasting" capabilities; a message typed once can be distributed to many users with no extra effort. Computer conferencing makes a kind of "classroom discussion" possible for independent home study students, a discussion that is perhaps more thoughtful and more open than in the classroom; participants can take time to formulate contributions and word them carefully, and slower and shyer students have more of an opportunity to contribute. Computer conferencing also exercises students' general written communication skills.

Computer conferencing can be an expensive and inaccessible medium if it includes the purchase of a central computer with hardwired or modem-based terminals for participants. The software can be equally expensive and require much staff time to support. Finally, it can also require much time and effort for participants to learn to use the hardware and software and/or time and effort on the part of the administrators to make the conferencing system easy to use.

At ELI, with a very limited budget, we looked first at our College's existing academic mainframe computer. This computer was originally intended for use by instructors to teach programming and systems development to computer science students. Some use is still made of it for this purpose, but the migration of the computer industry to personal computers and local area networks left this computer underused. A student programmer-oriented operating system (MUSIC) with a rudimentary electronic mail application was already running on this computer. In addition, there were hardwired terminals in computer labs on each of our five campuses, and there were 16 telephone dial-up ports for connection by modem. All of the basic hardware and software needed for computer conferencing were already in place and being supported by the College's computer center. What made this technology affordable for ELI was that it was in place and the computer conferencing system could ride along with the College's other functions including existing terminals and dial-in ports.

To create a computer conference, ELI staff programmed a more user-friendly interface for the electronic mail software and a mechanism for public access to documents, created student and instructor accounts that defaulted to the computer conference upon log in, and wrote a detailed user manual. All of this was done simultaneously with, and in support of, development of a technical writing course that used computer conferencing as the primary communication medium. The proposal for this course by an instructor was the driving force that initiated our experiment with computer conferencing. Creation of the computer conference required approximately two months of staff time distributed over an eight-month calendar period.

The technical writing course has been very successful over the past two years, and so has a psychology course begun a year ago. Students enrolling in these courses receive a course guide and a computer conferencing manual in the mail. The course guide describes written assignments that are to be posted to the computer conference. The manual tells students how to connect to the computer conference and how to write and post an introduction of themselves. Students are encouraged to view and comment on each other's assignments, and to work collaboratively when interests overlap. The instructors provide public comments on most assignments, but give grades privately. In their evaluations, most students say that the conference is easy to use (but limited in capabilities), and most appreciate the opportunity to see and learn from the work of others.

Students have the option of going to a computer lab on campus and using a terminal, or of using their own personal computer, modem, and telecommunications software to connect to the computer conference via the telephone; any personal computer and telecommunications software that can emulate a VT100 terminal can be used. Many of the students enrolling in the course use personal computers at home or at work to do their conferencing, but some travel to the campuses to use the terminals in the computer labs. Some effort was required to communicate to computer center and computer lab staff the needs and problems of distance learners and non-computer science majors. Since the ELI staff's idea of user-friendliness differed significantly from that of the computer center's staff, it was sometimes difficult to explain why certain features of the system were a problem and to get advice on how to circumvent them. There were frequent problems with the computer center's dial-in hardware, which had probably not been heavily used and debugged until our project began. Computer center and computer lab staff were oriented toward supporting daytime campus users rather than nighttime and weekend distance users. However, the computer center was quite interested in seeing the academic computer better used, and has made an effort to understand and support the needs of distance education.

In choosing to use a relatively old mainframe computer as the conference platform, ELI elected to use a centrally supported, multi-modem, mainframe computer with a line editor instead of a microcomputer based system with word wrap, block editing, and automatic reformatting functions. While the mainframe conference has its limitations, it does provide a full-screen format and the capability for uploading documents students create on their own word processors. This has proven sufficient for the short documents required of students in these courses and is an excellent means of communication among students and faculty.

Current ELI plans related to computer conferencing include easing our administrative load by using unenhanced electronic mail software and student accounts, training selected campus instructors to use computer conferencing to support classroom instruction, adding access to on-line library catalogs, adding computer-assisted instruction capabilities, and providing inexpensive modems through the College bookstores. All of these will be done with an eye toward minimal budgets and maximum access for students.

VOICE MAIL

Technology and electronic media have, in fact, made us "distance learners" and changed the ways in which we can communicate. What is important for teachers is how we use this technology to provide learning situations which are comparable to traditional classroom learning situations. This is particularly true for the foreign language teacher and learner.

In the Fall, 1990, we began to teach French through a distance learning television course. Students viewed the telecourse **French in Action** on the College cable TV network and sent in their written assignments by mail and fax, their oral assignments by personal audio cassettes. The provision of televised lessons was relatively inexpensive in that the College already had a cable tv channel and access was open to all who had cable tv or who could travel to one of the College's five learning resource centers to view the lessons on tape.

Immediately, evaluations from students as well as concerns from the foreign language profession made us look at more effective ways to deal with oral assignments. Students told us, that while they appreciated the flexibility of the TV course, what they missed was the interaction between teacher and student, the immediate answers to questions and more important, feedback on their oral production. This became a different form of access in that it required a faster communication method that what could be done via the mail. Two way television capabilities were not present over the College's cable tv channel.

At the same time, the foreign language profession was critical of distance learning programs because students in these programs did not develop adequate speaking skills. The National Council of State Supervisors of Foreign Languages, together with the American Council on the Teaching of Foreign Languages have developed guidelines (1990) for foreign language distance learning programs. These are to include live interaction between student and teacher, activities to provide for listening and speaking skills, and immediate individualized feedback on student oral performance.

The voice mail system, with a personal mailbox for the instructor and a personal mailbox for each student registered in the course, has enabled us to solve this access and speed problem. The system was originally set up on a 7-year old IBM PC compatible with limited memory and storage capacity. The voice mail board was commercially available and required some knowledge of computers to write the files necessary to set up the board and the computer. Currently a newer computer with a larger hard drive and more voice mail capabilities (total costs about $1000) is being used.

The voice mail system is being used in three different ways:

1. The instructor's personal mailbox serves as the means for students to ask questions and leave messages for the instructor, from asking about a difficult grammatical point, to the explanation that the baby has been sick or I will be out of town and my assignments will be a little late.

2. Students leave their weekly dialogues on the system and the instructor gives them immediate feedback on their oral production on their personal mail box. These dialogues range from the simple 10-line dialogue to a discussion of describing a vacation or arguing the advantages of TV publicity. These dialogues are designed to simulate telephone conversations.

3. As a means of developing listening comprehension skills, each week there is a listening comprehension quiz left on the voice mail system for students. Quizzes range from simple recognition of vocabulary and grammar from the text to understanding a message about the weather, movie schedules, or travel arrangements. These more complicated listening quizzes are intended to simulate daily, real-life situations of calling for information or calling to talk to a friend.

The advantages of the voice mail system have been many. It is economical to install and it is easy for students to use. Everyone has access to a telephone and students are used to making business calls, personal calls, and calls for information. The system is flexible and available when they need it. Students may call 24 hours a day, 7 days a week and, when their work schedule has taken them out of town, some have called in their dialogues from out of state.

From the instructor's point of view, there have been some unforeseen advantages. One has been the ability of the voice mail system to personalize the relationship between student and instructor so that the students in the distance learning class are known as well as students in traditional classes. Furthermore, the isolation of the student from the classroom has been helpful to a number of students by lowering the anxiety they might have experienced in speaking in front of an instructor and classmates. Several of them have said that they could not have achieved the level of speaking proficiency had they been in a traditional classroom setting. This is particularly true of adult learners who are returning to the classroom after a long absence.

AUDIO CONFERENCING

Audio conferencing is an inexpensive means of allowing students and faculty to converse without the need for anyone to commute to campus. Audio conferencing is a fully developed technology and one that the State of Virginia provides through a "meet me" phone bridge. At a prearranged time, students and faculty call a designated local phone number using their own telephones and connect with each other in a multi-party conversation. A phone bridge provides better conversation patterns than most conference call systems built into students' phones since more people can participate and switching between speakers is more natural. In Virginia, the arrangement of these conferences is extremely easy; it takes only telephone call to a central operator who designates a phone number and allots time to the audio conferees.

Examination reviews, homework help, oral practice in language classes, and other instructional applications are made possible with the phone bridge. Courses that are paced for group work can especially benefit from this technology because it allows for groups to meet without driving to a campus. It does, however, require that everyone participate at the same time since this is a real-time telephone conversations. A tape delayed version of this conference can be made available for class members who do not participate in the live conversation, but they would not have the opportunity to contribute to the discussion. Similarly, since this is an audio conference no visual images are shown, but they can be sent in advance to conference participants so that all can refer to the same documents. Physical access to audio conferencing is almost total as most people have telephones and the speed of communication is instantaneous. Participation can be limited by students' and faculty members' busy schedules.

LOCALLY PRODUCED VIDEO

Finally, locally-produced videos can be used to capture discussions or meetings for show later time to other class members. These short video programs can be produced by the College or by students who have access to VHS camcorders. At ELI, the College's tv studio offers a quick means to capture visual images with accompanying audio and distribute them to students. Courses that rely heavily on printed material can be enhanced with 4-5 hours of video. These 4-5 hours are locally produced and usually feature the instructor presenting visual images or a dialogue that would not be as effective in print. Production is simple in that the College has a telecourse production studio that uses fixed cameras where the instructors switch between a head shot of themselves and a graphics camera of their handouts. The only required technician monitors the recording of the video in the studio's control room. ELI has used this for whole courses, for the 4-5 hours of supplementary video mentioned earlier, and for 3 hours of wrap-around video that accompanies telecourses licensed from PBS or other vendors.

The viewing of this video takes place on cable tv, at the campus learning resource centers, and through circulation of copies of the tapes. Production of video by students will increase as they get more access to camcorders and begin to use them to send in their assignments or other communications. Speeches, biology laboratory experiments, history field trips, and other such assignments can be easily recorded on a camcorder by students and submitted to instructors for review and feedback.

CONCLUSION

Ordinary, relatively low-cost, and readily accessible technologies are prime tools for distance education courses. While two-way audio and video may be a primary future technology, telephones, inexpensive computer connections, and locally produced video are tools that can be employed immediately in many colleges and universities. The communication facilities of most colleges, as in the case of NVCC, offer course administrators, designers and faculty readily available tools for distance education. Use of these in voice mail, computer conferencing, audio conferencing, and locally produced video can speed the rate of communication, increase its quality, and make it possible for faculty to improve the learning experiences of their students.

Title:

The Development and Evaluation of a Self-Regulated Learning Inventory and its Implications for Instructor-Independent Instruction

Authors:

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The Development and Evaluation of a Self-Regulated Learning Inventory and its Implications for Instructor-Independent Instruction

Few would argue with the claim that the ideal learner/student/scholar is organized, autonomous, self-motivated, self-monitoring, self-instructing, in short, behaves in ways designed to maximize the efficiency and productivity of the learning process. We would like our classrooms to be filled with such learners. Unfortunately, they rarely are. Our students, all too frequently, are underprepared and/or unmotivated with respect to productive academic performance. Given present day cultural and economic conditions, the consequences of academic underachievement can be disastrous, both for the individual and our society as a whole (National Commission on Excellence in Education, 1983; Jones & Idol, 1990).

Not surprisingly, a general call has gone out to the educational community to find ways of improving student performance. Such improvement will require changes on a variety of fronts. Current emphases on changing our curriculum, standards of achievement, and educational choice surely represent important steps in the right direction. However, equal attention must be paid to factors more or less directly under the learner's control. Too great an emphasis on the role of external conditions and factors tends to suggest that student performance is, in large measure, determined by forces outside of the learner's control; that good students are the products of education rather than the producers of educational outcomes. Such a view lacks balance and may be seriously misleading. Why are some students successful despite less than optimal educational conditions? The reasons are surely complex. One set of factors that are likely to prove significant involves what has come to be called **self-regulated learning** (Borkowski, et. al., 1990; Zimmerman, 1990).

The self-regulated learning perspective is multi-faceted and draws on contemporary developments on several theoretical fronts. Nevertheless, according to Zimmerman (1990 , p.4), "a common conceptualization of these students has emerged as metacognitively, motivationally and behaviorally active participants in their own learning." In other words, self-regulated learning is purposive, goal oriented and involves behaviors designed to maximize academic performance. While all students, barring those who are totally tuned out, are probably active in the manner just described, self- regulated learners appear to be both more keenly aware of the relation between specific behaviors and academic success and more likely to systematically and appropriately employ such behaviors. Perhaps most importantly, self-regulated learners are successful learners (Zimmerman & Pons, 1986). It follows that understanding the behaviors and processes that underlie self-regulated learning represents an important goal for educational researchers.

Contemporary approaches to self-regulated learning (although not limited to) are presently dominated by two main theoretical frameworks: Social learning/cognitive theory and information processing theory. Zimmerman and Pons (1986), for example, working out of the former, have defined self- regulated learners in terms of fourteen dimensions which span a spectrum from cognitive to behavioral to social factors.

A variety of research either specifically identified as focused on self-regulatory processes (Borkowski, Carr, Rellinger & Pressley, 1990; Pressley & Ghatala, 1990), or indirectly concerned with self-regulatory mechanisms (Baker 1989; Brown 1978; Glenberg, Wilkinson & Epstein, 1982; Justice & Weaver-McDougall, 1989; Leal 1987; Spring, 1985), has been conducted from an information processing orientation. The primary dimensions of interest for information processing theorists include metacognitive processes, learning strategies, and motivational factors related to self-attributions (the latter also being an area of interest for social-cognitive theorists). Clearly, self- regulated learning is a multi-dimensional and complex phenomenon that transcends boundaries of interest that have separated researchers operating out of differing, and sometimes competing, theoretical orientations.

While our own research, at this juncture, has not been primarily theoretically motivated, we did find it necessary to impose an organizational structure on the various dimensions of self-regulated learning reported in the literature. We believe, in fact, that the model we have generated may be one of the more useful elements emerging out of our efforts. Our working model of self-regulated learning presently consists of five dimensions: **Metacognition, learning strategies, motivation, contextual sensitivity** and **environmental utilization/control** (see appendix A for our model and examples of our categorization scheme). In developing this model, we reasoned that the successful learner must both internally (we use the terms internal and external in a relative sense only since no absolute separation in the meaning of theses concepts as psychological constructs is possible) regulate, monitor, evaluate and modify, when necessary, the learning process, and be sensitive to and utilize or control contextual (external) factors such as course and instructor demands, where and when to study, who to go to for assistance, etc. Most of the various self-regulated strategies reported in the literature fall into one or another of the categories we have chosen. We argue, for example, that self-monitoring and self-evaluation are best construed as aspects of the metacognitive component of the learning process rather than as independent categories as in, for example, the scheme of Zimmerman and Pons (1986). The same reasoning can be applied to various categories of information processing reported in the literature (Pintrich, Smith & McKeachie, 1989; Weinstein, Zimmerman & Palmer, 1988) which we subsume under the broad notion of learning strategies (e.g., organizing and transforming, selecting main ideas, restating, etc.). Similar reasoning led us to subsume the interesting and important notion of epistemological beliefs (Shommer, 1990) under the general category of motivation.

Having devised a model of its components we felt was both economical and intuitively compelling, we set out to determine if self-regulated learning indeed played a vital role in successful academic performance. We chose to do this by employing a self-report inventory of our own design, composed of five subscales consistent with our model of self-regulated learning. We opted to develop such an instrument because (1) to our knowledge no instrument of its kind existed, and (2) because we believe that measuring the extent to which a learner is self-regulating has important implications for designing individualized instructional interventions not typically taken into account by instructional designers. In what follows, we first describe the development of our diagnostic tool and what it reveals about the nature of successful academic performance. We then go on to discuss potential technology based applications and implications of our work.

Development of the Self-Regulated Learning Inventory. Our first step in the creation of a self-regulated learning inventory involved the generation of an item pool. We decided to review the literature and to construct our items on the basis of findings that reported strong relationships between learner-generated activities and academic success. The result was a pool of approximately 100 items. We then reviewed and analyzed the items eliminating those that were too much alike and rewriting those that were either too complex or too vague. This left us with a pool of seventy-one items all of which were included in our first instrument. Although the items represented five subscales, we decided to present them randomly as a single test. A five-point Likert scale format was chosen as most appropriate for this type of instrument.

A pilot run was conducted to see if directions were clear and sufficient, how long it took to respond to the inventory and if the items as written were clear and comprehensible. As a result, a formal set of instructions was composed. It was determined that time to complete the inventory ranged from 20-30 minutes (see appendix B for sample items).

Subjects. Our subjects were all students enrolled in classes in the college of education at a medium size mid-Western University. Unfortunately, the majority of education majors continue to be female. Thus, our sample contains an imbalance in terms of males (21) and females (83); a weakness we are seeking to redress. Permission was granted to administer the inventory to intact classes by several instructors. Classes ranged in size from thirty to ten. In total, the inventory was responded to by 120 students. Only 104 cases were actually analyzed due to the failure of some students to properly report requested information and, in some cases, due to questionable patterns of responding such as circling the same number for every (or nearly every) item.

Procedure. The inventories were administered in every instance by either one or the other of the authors. Having obtained prior permission from class instructors, we passed out the inventories and read the prepared set of instructions. Although participation was entirely voluntary, no student refused to fill out the inventory.

Results. We first report on findings that relate to the technical properties of the inventory. Table 1 shows the results of an analysis of internal reliability of the inventory and its subscales. We are encouraged by these results, although by no means satisfied. Data for the calculation of test-retest reliability were unavailable at the time of writing this report, hence we are unable to provide this information at this time.

Table 1

Reliability Coefficients

	MCS	LSS	MOS	CSS	ECS
Alpha	.72	.77	.75	.59	.65

An analysis of the correlation between each of the items on the inventory and student GPA, as well as a correlation of each subscale item with the total score for that subscale, was conducted. Three items failed to correlate significantly with either subscale total score or GPA and will have to be replaced.

Our only evidence with respect to validity at this point is indirect. That is, our items were constructed on the basis of findings in the literature related to the construct we set out to measure. An analysis of the correlation between scores on the inventory and GPA, our measure of academic achievement, revealed a significant correlation both for the inventory as a whole and for each of the subscales (see Table 2). This result corresponds to findings as reported in the supporting literature.

Table 2

GPA and Scores on the Inventory

	MCS	LSS	MOS	CSS	ECS	SRLTOT
Correlation	.46**	.46**	.45**	.29*	.40**	.56**

* p <.01, ** p <.001

As noted, we selected student GPA as our measure of academic achievement. We have already shown that scores on the inventory and its subscales correlate significantly with GPA. The largest correlation obtained was between GPA and total score (SRLITOT). We also obtained information for each subject on class (F,S, JR, SR, GRAD), age, sex and race. Analysis of these data revealed a significant correlation between sex and total score on the inventory. Table 3 shows the scores for males and females on the inventory and its subscales. It can be seen that females outscore males on total score as well as all subscales except metacognition. While these differences are, in most instances, statistically significant, we hesitate in drawing a firm conclusion due to the small number of males in our sample.

Table 3

Sex X Inventory Score (mean scores)

	MCS	LSS	MOS	CSS	ECS	SRLTOT
MALE**	57.6	61	50.7	34.25	35.4	238.95
FEMALE*	57.49	66.4	54.3	36.44	38.01	252.95

** N= 83
* N= 21

The data for scores on the inventory and its subscales and class are presented in Table 4. While not statistically significant (p<.10), they do indicate the possibility of an interesting trend in student development; that is, that students become increasingly self-regulated as learners over the course of the college experience.

Table 4

Class X Inventory Score

	MCS		LSS		MOS		CSS		ECS		SRLTOT
	M	SD	M	SD	M	SD	M	SD	M	SD	M
SO	55.8	5.6	63.5	7.0	52.4	5.4	35.2	4.4	36.9	4.4	243.8
JR	57.8	7.3	67.2	7.5	53.7	6.7	36.8	3.6	37.8	5.2	253.4
SR	58.4	5.1	64.8	5.0	54.7	5.5	35.4	2.9	37.4	3.9	250.9
GR	61.0	7.3	65.3	11.1	54.5	6.6	38.5	5.8	39.5	1.7	258.8
Total Possible	85		90		75		50		55		355

Note: SO - N=31, JR - N=41, SR - N=27, GR - N=5.

Discussion. Our results lead us to conclude both that self-regulated learning is an important component in academic success and that it can be measured via a self-report instrument. The results of our analysis of the data indicate a substantial relationship exists between self-regulated learning and GPA. This result is in line with published research on self- regulated learning (Zimmerman & Pons, 1986, 1988; Zimmerman, 1990). The fact that total score showed the highest correlation with performance is in line with the work of Zimmerman & Pons (1988) who also found self-regulated learning could be treated as a single, overarching factor. Our results further suggest that successful students may become increasingly self- regulating over the course of the college experience. This finding, however, needs further exploration.

Our research, as well as the research of a number of others (Zimmerman, 1990) lends support to the claim that self-regulatory skills are important components of successful academic performance. The question is: what implications do such findings have for the design of instructor-independent facilitation of the learning process? Two elements appear to be essential to designing effective ways of facilitating the acquisition of complex cognitive skills: an understanding of the learner and the learning process, and properly anchored learning contexts, or practice environments. Our model of self-regulated learning, we think, provides a viable, comprehensive, and relatively unique basis for the former. Our inventory, which could be electronically administered, allows for diagnostic predetermination of the level of self-regulation present in a particular learner. Such information is likely to prove crucial for determining the degree to which a particular learner is ready to benefit from instructor-independent instruction. The fact that a given learner may be more or less able to self-regulate also suggests that a variety of instructional options must be developed to suit the needs of different types of learners. Specifically, it may be necessary, when self-regulatory skills are deficient, to develop instruction designed to counteract this deficiency. As to the problem of anchoring instruction, we believe that computer, particularly multi-media, based approaches offer the most viable and cost effective solutions.

There are several reasons why we believe videodisc technology and multimedia offers a viable solution path to instructional interventions of the kind we have in mind. As noted, a general theme in contemporary instructional psychology is that effective instruction must be contextually grounded, or "situated" (Brown, Collins & Duguid, 1989; Cognition and technology group at Vanderbilt, 1990). From this perspective, instruction, ideally, would take place within real-world settings resembling as much as possible the actual contexts in which the skills to be learned would be applied. Practically speaking, however, such an approach is difficult, perhaps impossible, to effect on a grand scale. To make matters worse, such a strategy presents additional difficulties for instruction in skills considered not part of the standard curriculum. Videodisc technology, however, lends itself to a reasonable compromise. At the very least it should be possible to create problem contexts that resemble closely real-world situations for students to ground their learning experiences in. In terms of our own aims, it should be possible to recreate the context of academic tasks faced by students in real classrooms by using videodisc technology to lend a sense of reality to instruction aimed at promoting self-regulatory skills. At the same time, since these would be true-to-life **simulations**, students would have the opportunity to try out various strategies without the pain of a failed exam or course. Furthermore, since metacognition is vital to self-regulated learning, a computer-based approach allowing for use of the instructional program as a temporary self-reflective "executive" that prompts (thereby increasing awareness), monitors and evaluates performance, appears a potent method for the building of this crucial component of skilled learning.

REFERENCES

Baker, L. (1989). Metacognition, comprehension monitoring, and the adult reader. *Educational Psychology Review*, 1, 1, 3-38.

Borkowski, J.G., Carr, M., Rellinger, E. & Pressley, M. (1990). Self-regulated cognition: Interdependence of metacognition, attributions, and self-esteem. In, B.F. Jones & Idol, L. (Eds.), *Dimensions of thinking and cognitive instruction*. NJ: Erlbaum.

Brown, A.L. (1978). Knowing when, where, and how to remember: A problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology*, Vol. 1. Hillsdale, NJ: Lawrence Erlbaum.

Brown, J.S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18, 1, 32-42.

Cognition and Technology Group at Vanderbilt (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher*, 19, 2-10.

Glenberg, A.M., Wilkinson, A.C. & Epstein, W. (1982). The illusion of knowing: Failure in the self-assessment of comprehension. *Memory & Cognition*, 10.

Jones B.F. & Idol, L., Eds., (1990). *Dimensions of thinking and cognitive instruction*. NJ: Erlbaum.

Justice, E. M. & Weaver-McDougall. R. G. (1989) Adults' knowledge about memory: Awareness and use of memory strategies across tasks. *Journal of Educational Psychology*, 81, 214-219.

Leal, L. (1987). Investigation of the relation between metamemory and university students' examination performance. *Journal of Educational Psychology*, 79, 35-40.

National Commission on Excellence in Education (1983). *A Nation at Risk: The Imperative for Educational Reform.* Washington, D.C.: U.S. Government Printing Office.

Pintrich, P. R., Smith, D. A., & McKeachie, W. J. (1989). *Motivated strategies for learning questionnaire.* Ann Arbor: MI: University of Michigan.

Pressley, M. & Ghatala, E.S. (1990). Self-regulated learning: Monitoring learning from text. *Educational Psychologist*, 25, 19-33.

Shommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82, 3, 498-504.

Spring, C. (1985). Comprehension and study strategies reported by university freshmen who are good and poor readers. *Instructional Science*, 14, 157-167.

Weinstein, C. E., Zimmerman, S. A., & Palmer, D. R. (1988). Assessing learning strategies: The design and development of the LASSI. In C. E. Weinstein, E. T. Goetz & P. A. Alexander (Eds.), *Learning and study strategies: Issues in assessment, instruction, and evaluation.* NY: Academic Press.

Zimmerman, B.J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist*, 25, 3-17.

Zimmerman, B.J. & Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal*, 23, 614-628.

Zimmerman, B.J. & Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology*, 80, 3, 284-290.

Appendix A
Dimensions of Self-Regulated Learning
A Working Model

A. Metacognition

Definitions

1. Regulation of cognition
   a. Planning/deciding
   b. Monitoring
   c. Evaluation/checking
2. Knowledge about cognition
   a. Knowing **what** to do
   b. Knowing **how** to do
   c. Knowing **when** to do
   d. Knowing **where** to do
3. Self-reflective awareness

Types

1. Metacomprehension
   a. Text processing
   b. Listening skills
2. Metamemory
   a. General strategy knowledge
   b. Metamemory acquisition procedures
   c. Specific strategy knowledge

B. Learning Strategies

Definitions

1. Plans organized to facilitate successful learning
2. Skills specific to achieving learning goals
3. Procedures that accomplish academic goals

Types

1. Text processing strategies
   a. Underlining main ideas
   b. Summarization
   c. Using imagery
2. Lecture/discussion processes
   a. Notetaking
   b. Graphic representation
   c. Recasting

C. Motivation

Definitions

1. Awareness of the relationship between effort and outcome
2. Sense of mastery/competence
3. Desire to learn

Types

1. Causal attributions
2. Locus of control
3. Self-efficacy
4. Epistemological Beliefs

D. Contextual awareness/sensitivity

Definitions

1. Ability to gauge task demands
2. Ability to balance task demands with personal resources
3. Ability to judge the relationship between learning task and assessment

Types

1. Cue sensitivity
2. Congruence assessment

E. Environment utilization/control

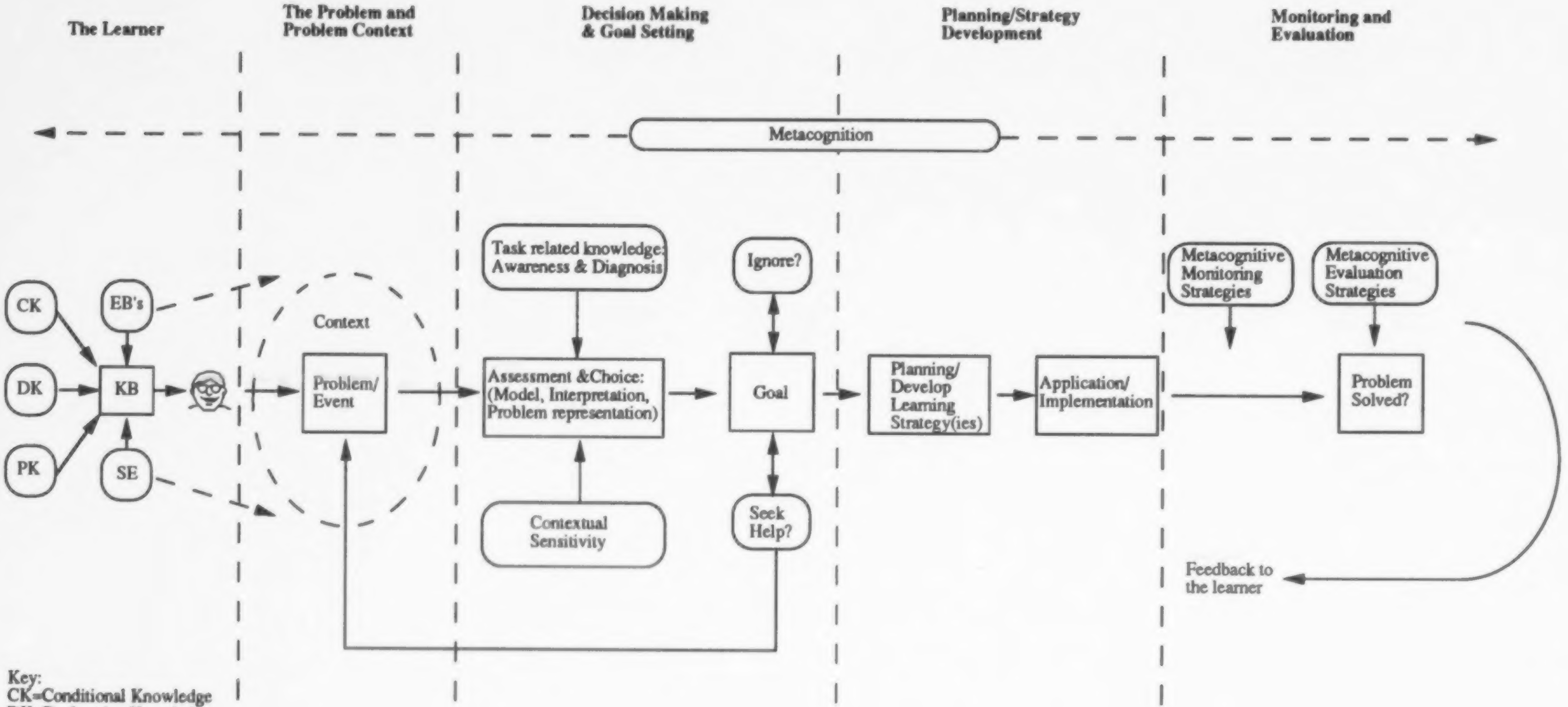
Definitions

1. Knowing where to find assistance
2. Planning and scheduling
3. Establishing a learning environment

Types

1. Help seeking
2. Goal setting
3. Staging

Appendix A (continued)
Self-Regulated Learning Model


The Learner
The Problem and Problem Context
Decision Making & Goal Setting
Planning/Strategy Development
Monitoring and Evaluation
Metacognition
CK
DK
PK
EB's
KB
SE
Context
Problem/ Event
Task related knowledge: Awareness & Diagnosis
Assessment &Choice: (Model, Interpretation, Problem representation)
Contextual Sensitivity
Ignore?
Goal
Seek Help?
Planning/ Develop Learning Strategy(ies)
Application/ Implementation
Metacognitive Monitoring Strategies
Metacognitive Evaluation Strategies
Problem Solved?
Feedback to the learner

Key:
CK=Conditional Knowledge
DK=Declarative Knowledge
PK=Procedural Knowledge
EB's=Epistemological Beliefs
SE=Self-Efficacy
KB=Knowledge Base

Appendix B
Subscales of The Self-Regulated Learning Inventory with Sample Items

I. Metacognition Scale

1. After studying, I mentally review the material to get a sense of how much I have remembered.

2. When reading a text, or reviewing my notes, I periodically pause and ask myself: Am I understanding any of this?

II. Learning Strategy Scale

1. When preparing for an essay-type exam, I try to put the material I am studying into my own words.

2. When I need to remember a list of items or names, I actively recite or rehearse them until I can recall them from memory.

III. Motivation Scale

1. I prefer courses that are moderately challenging to easier ones.

2. If I have a good instructor, I do well. If I have a poor instructor, I do poorly. It's that simple.

IV. Contextual Awareness/Sensitivity Scale

1. The type and demands of a particular course have a lot to do with the kind and amount of studying I engage in.

2. I try to determine what a particular instructor is looking for in terms of performance on the part of students and adapt my approach to the course accordingly.

V. Environment Utilization/Control Scale

1. When I study, I make sure I have enough time and a quiet place to go.

2. If I find I do not understand material covered in a text or in a course, I try to get help from someone who does.

Title:

The Relationships of Personological Variables to Computer Use by Elementary School Teachers: Report of Phase One - Baseline Data

Authors:

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Barbara L. Grabowski

Abstract

A questionnaire was administered to one hundred and sixty-seven preservice elementary education undergraduates. The questionnaire was designed to assess the relatedness of personological variables to the expected use of computers in teaching by preservice student-teachers. The data collected comprise the baseline for a five-year longitudinal study that is to be conducted over four phases.

Discrepancy Identified

With computers becoming increasingly available in schools, it is widely believed that educational technology—especially computer technology—could have a major positive impact on improving the educational system. This view has gained the endorsement of federal researchers (see The National Task Force on Educational Technology, 1986; United States Office of Technology Assessment [OTA], 1988)...academic scholars (Sheingold and Hadley, 1990)...and educational politicians (Albert Shanker, 1990). Perhaps due to the favorable disposition of opinion leaders towards computer technology in education, computers for teaching have become increasingly available. In the period from 1983 to 1987, the average pupil-to-computer ratio in public elementary schools improved from 112.4 to 36.8 pupils per computer (OTA, 1988).

Yet, in spite of these positive trends, computers remain underutilized by teachers. While researchers support the continuing increase in the availability of computers, they note this caveat—that the key to profiting from computers does not lie in their sheer presence; but rather, in the way in which they are used (see Berman & McLaughlin, 1978; NTFET, 1986; Salomon & Gardner, 1986). Unfortunately, a relatively small number of teachers have integrated computers into their teaching. Sheingold and Hadley's survey (1990) has shown even in schools where the availability of computers per school was more than double the national average there was only about one teacher per school who integrated the computer into their teaching.

Disturbingly, there is a strong sentiment among teachers that several promising breakthroughs in educational technology have not realized their widely-held expectations for revamping education (Ely & Plomp, 1988). Note the assertions of the titles to these articles "Computer Integration in Instruction Is Stuck...," (Dronka, 1985), or,..."Computer 'Revolution' [Is] On Hold..." (O'Neill, 1990), or,..."The Revolution That Fizzled" (Bjerklie & Hollis, 1991). Teachers have reported disillusionment with educational technology. Also, some writers suggest that there is little research evidence on the effectiveness of educational technology and that which exists provides little direction for teachers in how to use the technology most appropriately (Becker, 1987; Roblyer, 1988). The opinion of and use of educational computing by teachers does not seem to agree with the views of federal researchers, academic scholars, and educational politicians and their expectations for the use of educational computing.

We hypothesize that there may be several personological variables which influence teachers to use computers in their teaching. We reasoned that if teachers still did not integrate computers into their teaching in professional educational environments where computers were readily or reasonably available, then an examination of selected teachers' internal variables would be informative. Researchers which support the effect of personological variables on behavior include Gagné, 1978; Gilbert, 1975; Keller, 1983; Vroom, 1966. Before discussing the personological variables though, the situation which is established by the condition of availability is considered.

Availability/Exposure/Cognitive Dissonance

The availability of computers to teachers in a school causes a situation that would be termed "forced exposure" in the theory of cognitive dissonance (Festinger, 1962, p. 133). This means that exposure to the computers is inevitable and occurs regardless of a teacher's intentions. The theory predicts that in this situation a person's response would be one of either information seeking or avoidance. This situation is key to this study since an examination of the personological variables related to a teacher's response to computers can only reasonably occur when computers are available in a teacher's work environment. Because the baseline data were collected with preservice undergraduate teachers, their responses could not reflect their actual use of computers for teaching. Rather, the preservice teachers were instructed to respond to the portion of the assessment measuring *use* in terms of what they *expected to be true* in the future regarding their use of computers in teaching. In the later phases of this study when the subjects are professional teachers, the availability of computers in the subjects' schools will be required in order for the subjects' to remain eligible. Presently, availability has been defined as a maximum pupil-computer ratio of 44 to 1 (Marcinkiewicz, 1991).

The availability of equipment is a reasonable prerequisite for the accomplishment of work, but availability itself is insufficient. One line of thought suggests that forced exposure be extended to forced use. In other words, whether or not a teacher were inclined or predisposed to use computers would be subordinated by the requirement of use. A realistic expectation is that teachers' use of computers would be pro forma if it were mandated by their administration (Berman & McLaughlin, 1978, p. 15). What is not clear is the extent to which teachers would use available computers if they were *not* directed to do so. The following section discusses the variables which will be examined in the subsequent phases to determine whether they are predictive of teachers' computer use.

Predictor Variables

The variables that were hypothesized to predict computer use include age, gender, experience with computers, innovativeness, teacher locus of control, perceived self-competence in computer use, and perceived relevance of computers to teaching. The first three demographic variables are exogenous—they are influential but are not subject to intervention. The latter four are endogenous—they are influential and are subject to intervention. The selection of this set of variables is substantiated by well founded theories and by empirical evidence which relates them to computer use. Knowledge of the predictive relationship of any of these variables to computer use would be informative for intervention with teachers or for differential staffing.

Computer Use

Computer *use* was operationally defined as the integrated employment of computers in the classroom. This dimension was derived from a model of Instructional Transformation described by Rieber and Welliver (1989) and Welliver (1990) in which a teacher progresses through levels of involvement with computers. At the first level, a teacher becomes familiar with computers (*familiarization*); then, begins to use computers in teaching (*utilization*). A higher level of use is observed when the teacher's computer use becomes critical to his or her teaching (*integration*). At this level, teachers consciously and inextricably dele gate some of their duties to the computer and are aware of the changes to their role as a result. It is at this level too that the teacher is aware of the changes to the teacher's role as a result of the integration of computers. For a teacher, this new awareness of the restructuring of instructional activities leads to a pursuit of fine tuning the computer-teacher-student relationship (*reorientation*). The final level (*evolution*) is more of a suggestion than a level—to continue practicing and learning about how to improve instruction through the systematic implementation of computer technology. Key to this level is that the teacher remain sensitive to, be prepared for, and be able to adapt to change. An analogy to this adoption of computer use would be that if upon learning to drive (familiarization), one uses a car to improve one's general transportation in order to fulfill a variety of purposes (utilization). One may then schedule the use of the car so that the vehicle is critical to the fulfilling of the purposes (integration). At the same time, one becomes aware that the new technology has significantly altered aspects of one's role. Computer *use*, therefore, was assessed with the Levels of Use (LU) assessment (Marcinkiewicz, 1991) which had been developed based on the model of Instructional Transformation.

Age

The relationship of age to computer use is as yet, unclear. Respondents to Sheingold and Hadley's survey (1990) of outstanding teacher-users of computers comprised a group, over half of whom were between 40 and 49. In research on innovation (Rogers & Shoemaker, 1971), the effect of age has shown mixed results. Rogers (1983) reports that the more mature favor change.

Gender

The differences in computer use between males and females suggests that there may not be equality in their education. Gilliland (1990) discusses differences in gender-attributable perceptions. For example, females were more negative in their attitudes towards computers and expressed lower expectations of computer use and computer usefulness than did males.

Sheingold and Hadley (1990) showed an equal distribution of computer users between male and female teachers. Jorde–Bloom and Ford's (1988) findings on gender were unclear because of the low number of males, although being male correlated more highly with several variables than did being female. Rogers (1983) indicates that females typically showed lower levels of acceptance of innovative behavior than males. Gender differences were reported to correlate significantly with attitudes towards computer use (Dambrot, Watkins–Malek, Silling, Marshall & Garver, 1985). Males held more positive attitudes towards computers and scored higher in computer aptitude. Goldman, Kaplan, and Platt (1973) found that "mechanical curiosity" was consistent for both males and females in choosing college majors but that females "needed" less of this attitude than men even if they were successful science majors. Marcinkiewicz (1991) reports that gender did not predict levels of computer use for elementary school teachers.

Experience with Computers

The amount of experience an individual has in a specified behavior contributes directly to the individual's general tendency of expectations about that behavior (Rotter, 1954). Rogers' (1962) description of the adoption process describes an individual's mental interaction, or the organization and elaboration of thoughts and attitudes, with experience. In the adoption process, progression from awareness, interest, evaluation, trial, and finally, adoption is influenced by experience. Experience is also elemental to Rieber and Welliver's (1989) description of the *familiarization* level of the model of Instructional Transformation. At that level familiarity with computers develops through a teacher's experience with them.

Computer attitude has also been related to computer experience (Dambrot et al, 1985). Jorde–Bloom and Ford (1988) found that experience with and knowledge of computers and experience with educational innovations were among the factors with the strongest positive relationship to computer use by early childhood education administrators. For Sheingold and Hadley's survey (1990), 73% of the respondents used computers in their teaching for five years or more. Marcinkiewicz (1991) reports that computer experience did not predict levels of computer use elementary school teachers.

Innovativeness

Rogers and Shoemaker (1971) define innovativeness as the degree to which an individual is relatively earlier in adopting innovations with respect to others in a social system. Innovativeness is a stable personality measure in relation to the diffusion of innovation.

In their development of the Innovativeness Scale, Hurt, Joseph, and Cook (1977) have focused on the measurement of an individual's "willingness to change." This is the focus for this study. An individual's predisposition for change is measured by using self-report measurements. Marcinkiewicz (1991) reports that innovativeness did predict levels of computer use by elementary school teachers.

Expectancy Theory: Valence, Expectancy, Instrumentality

Three variables were selected to represent the components of expectancy theory. In the scheme of expectancy theory of behavior, there are three components of perception: 1) *valence*, which refers to some goal one values or desires; 2) *expectancy*, which refers to the expectation that by one's effort one is capable of achieving some performance; and 3) *instrumentality*, which refers to the belief that the achieved performance actually results in acquiring the valued goal (Vroom, 1964). For example, expectancy theory would predict that one would be motivated to use a computer for teaching if one believed that expending a modest amount of effort would result in competent use of the computer (expectancy), and using the computer would be instrumental in achieving a valued goal (instrumentality) such as better instruction/learning. The goal of improved instruction is valued by the teacher (valence). Valence of improved learning was assumed to be uniformly true for this sample. Expectancy and instrumentality were measured. Expectancy was assessed by teacher locus of control and the reported subjective probability of one's capability to use computers competently. In this study, computer expectancy referred to the degree to which one felt capable of achieving competence in using the computer in teaching. Instrumentality was gauged by assessing one's "perceived relevance of computers to teaching." In this study, this referred to the degree to which one perceived computer use as being instrumental in or key to achieving the valued goal of better learning by students (For the remainder of this discussion this variable will be referred to as *perceived relevance.*)

Locus of control is working in tandem with "self-efficacy" theory in accounting for the expectancy component of the above theoretical framework. Locus of control refers to a person's belief that the outcomes of a behavior are dependent on one's own actions, fate, or luck. Self-efficacy refers to a person's belief as to whether or not he or she is capable of a certain performance. Studies of locus of control have supported prediction of a person's future behavior and a person's initiative in controlling his or her environment (Rotter, 1966). Studies of self-efficacy have predicted performance not predicted by locus of control such as academic performance, tendency towards anxiety, etc. (Manning & Wright, 1983; Taylor & Popma, 1990). The comprehensiveness and independence of the two constructs as measures of expectancy is strongly debated (Bandura, 1982, 1989). It is not suggested that the measure included in the questionnaire has captured the complexity of the construct of self-efficacy; "the subjective probability of using computers competently in teaching" variable may be related to self-efficacy and only nominally measure expectancy. However, by including this measure, a different aspect of expectancy can be assessed apart from that assessed by locus of control. (For the remainder of this discussion this variable will be referred to as *self-competence.*). Gallo's investigation (1986) predicted individuals intentions to use computer technology using a formula for expectancy theory. Marcinkiewicz (1991) reported that "the subjective probability of using computers competently in teaching"—a concept related to self-efficacy—did predict elementary school teachers' levels of computer use. Indeed, in Marcinkiewicz' study, teacher locus of control was also measured but was not identified as a predictor of computer use. It was however, correlated with the self-competence variable.

Measures Selected: the Component Assessments

The dependent variable in this study was three categories of computer use: 1) Nonuse; 2) Utilization; and 3) Integration.

The independent variables were 1) age, 2) gender; 3) experience with computers; 4) perceived relevance of computers to teaching; 5) the subjective probability of the competent use of computers in teaching; 6) teacher locus of control; and 7) innovativeness.

The questionnaire used in this study comprised several component assessments (See Table 1). They were 1) the Levels of Use (LU) assessment; 2) the Innovativeness Scale (IS); 3) the assessment of perceived relevance of computers to teaching; 4) the assessment of subjective probability of capability to use computers competently in teaching (self-competence); 5) the Teacher Locus of Control scale (TLC) and 6) the Teacher Role Survey (TRS). Data for three demographic variables: age, gender, and years of computer experience were also collected. Also, an item for self-rating one's use of computers was included to estimate criterion-related reliability of the LU assessment.

Use of computers was assessed with the LU assessment (Marcinkiewicz, 1991) in which paired comparisons were used. This technique was appropriate because cut-off levels of computer use were defined which were mutually exclusive and exhaustive. This method is considered the "...most exact psychophysical tool..." useful for precise information concerning judgments or preferences (Nunnally, 1959, p. 20–21). The levels of utilization and integration are represented by two items each. One item from the utilization level is paired with an item from the integration level. The response procedure is forced choice; therefore, the subject is directed to select the statement which he or she most strongly feels is true about him or herself. Because the subject was asked to respond to each of the items twice, any inconsistency in responding was readily evident.

Validity of the Levels of Use Assessment (LU)

One control item was included on the questionnaire which was not computed in the data analysis. Respondents were to select from three descriptions, the one which best matched their expectation about their teaching in a given situation. This item was written to reflect the same dimension of use as in the LU but from a different perspective. Its function was to provide an additional measure about the teachers' self-report of use from which criterion-related validity could be established. A measure of association between it and the LU was computed. Subjects' responses to this item were matched with their levels of use. Cohen's kappa (Crocker & Algina, 1986, p. 198–202; Suen, p. 165–167) was computed to estimate the consistency of classification of the measures (kappa = .72).

Reliability of the Levels of Use Assessment (LU)

Reliability was estimated using the Coefficient of Reproducibility (*CR*) which also demonstrated that the items of the LU formed an ordered scale. The *CR* for the LU component of the questionnaire was *CR* = .96 (Marcinkiewicz, 1991). A *CR* of .90 is considered the criterion for demonstrating that the items form an ordered scale of allowable response patterns (Bailey, 1987, 348; Crocker & Algina, 1986, p. 56).

Table 1
The Variables and Their Related Instruments

	Dependent variables	Instrument	Reliability	Validation
1.	expected levels of computer use for teaching	Levels of Use (LU) assessment	Coefficient of Reproducibility $CR = .96$ ($n = 170$) kappa = .72	content, face, criterion-related—correlation of self-rating item with the LU
	Independent variables			
2.	innovativeness	Innovativeness Scale (IS)	$r = .89$	construct, predictive
3.	perceived relevance	one item	N/A	content
4.	self-competence	one item	N/A	content
5	locus of control	Teacher Locus of Control Scale (TLC)	*KR 20*= .81 for I- subscale and .71 for the I+ subscale. Item total *r* were significant ($p<.01$)	criterion-related, predictive
6	locus of control	Teacher Role Survey (TRS)		criterion-related, predictive
	Demographic variables			
7.	age	number years	N/A	N/A
8.	gender	male or female	N/A	N/A
9.	computer experience	number of years	N/A	N/A

The Innovativeness Scale (IS)

Hurt, Joseph, and Cook's (1977) Innovativeness Scale (IS) was developed to capture a particular aspect of innovation, the "willingness to change." This aspect of innovation was appropriate for this study since it identifies a predisposition—a personological variable. The IS is an instrument requiring self-report scored on a 7-point scale. Responses are scored as 7 = strongly agree; 6 = agree; 5 = moderately agree; 4 = undecided; 3 = moderately disagree; 2 = disagree; 1 = strongly disagree. The scoring has been designed so that a higher score indicates a higher degree of innovativeness. There are two forms of the IS—the original 20-item form and a shortened 10-item form. The shortened form was used to expedite the completion of the questionnaire. Its use was supported by the strength of its relationship to the original ($r = .92$).

Validity of the IS

The authors (Hurt, Joseph, and Cook, 1977) claim of construct validity is based on the correlated distribution of responses of their study with the distribution of innovator types identified by Rogers and Shoemaker (1971) on the basis of actual adoption. Secondly, innovativeness is characterized as being unidimensional. The factor analyses conducted by Hurt, Joseph, and Cook revealed that the factor structure of the IS was unidimensional.

Evidence has been reported supporting the predictive validity of the IS. Witteman (1976) hypothesized that high levels of innovativeness would be related to high levels of opinion leadership. Witteman also hypothesized that innovativeness would be negatively related with communication apprehension. There was a significant linear correlation of .50 between the responses to the IS and the measure of opinion leadership ($n = 936$). There was a significant linear correlation of -.45 between responses to the IS and the measure of communication apprehension.

Reliability of the IS

Reliability for the 20-item form of the instrument was estimated using a *KR - 20* for making all possible split-half comparisons (Hurt, Joseph, & Cook, 1977). This analysis resulted in an estimated reliability coefficient of *KR-20* =.94. Furthermore, all of the 20 items "discriminated significantly" (1977) between the upper and lower 27% of the distribution. The shortened form was made up of 10 of the original 20 items which had the highest item-total correlations. The 10-item shortened form has an "...internal reliability of $r = .89$,..." and its correlation with the 20-item scale is $r = .92$.

The Perceived Relevance of Computers

Subjects rated their agreement with an item stating that computers were relevant to teaching. They rated their perceptions on a 7-point scale. Responses were scored as 7 = strongly agree; 6 = agree; 5 = moderately agree; 4 = undecided; 3 = moderately disagree; 2 = disagree; 1 = strongly disagree.

The Subjective Probability of Competence

Subjects rated their agreement with an item stating that they perceived themselves as capable of using the computer competently in teaching. They rated their expectations on a 7-point scale from strongly agree to strongly disagree (1).

Teacher-Related Locus of Control Scales

A principle question in this study was to determine whether a teacher's locus of control is related to his or her level of computer use . The Teacher Locus of Control (TLC) Scale by Rose and Medway and the Teacher Role Survey (TRS) scale were selected because they were designed to measure the construct for teachers.

Teacher Locus of Control Scale

The TLC was appropriate because it measured teachers' beliefs in their control over student outcome. This is the same construct expressed in the Rand report for the U. S. Department of Health, Education, and Welfare (Berman, & McLaughlin, 1978) as being the most instrumental in predicting implementation of innovation for teacher attributes. The TRS was appropriate because it focuses on teachers control over their situation as professionals.

The TLC scale comprises 28 forced-choice items where respondents must endorse an alternative identifying either external or internal control of classroom events. Fourteen of the items describe positive or success situations and 14 describe situations which are negative or failure situations. Each item has two stems representing the alternate loci of control. Separate scores emerge for each subscale: the belief in internal responsibility for student success (I+) and student failure (I-). Scoring is 1 point for the internal response only. The range of scores possible is from 0 to 28. Since the partitioning of values by the subscales was not relevant to this study, the total of all internal responses was used for a respondent's locus score.

Validity of the TLC.

Rose and Medway (1981) report two validity studies. In the first study of criterion-related validity, the TLC and Rotter's (1966) original locus of control scale, the I-E scale, were administered simultaneously to teachers undergoing training in innovative educational practices. After the training, the teachers were rated for their implementation of those practices by independent raters. Correlations for the TLC scores and the I-E scores with the independent ratings of teachers' implementation of innovative educational practices revealed that the TLC was related to the independent ratings whereas the I-E was not. The correlations are reported in Table 2. The I+ refers to the subscale measuring internality in the context of student success situations. The I- refers to the subscale measuring internality in the context of student failure situations.

Table 2

Correlation (*r*) Values for the TLC Subscales and Rotter's I–E Scale with Independent Ratings of Teachers' Implementation of Innovations

I+ (success)	I- (failure)	Rotter's I-E
.50*	.46*	.28
.46*	.36	.19
.34*	.40*	-.07
.48*	.42*	.09
.48*	.44*	.01
.55**	.62***	-.09
.37	.63***	-.18

(*$p < .05$; **$p < .01$; ***$p < .001$)

In the second study (Rose and Medway, 1981), the predictive validity of teachers' locus of control to teachers' classroom behavior types was examined. Both the TLC and the I-E scales were administered to teachers. For six types of behavior studied, the I-E resulted in only one significant correlation while there were five for the TLC.

Reliability of the TLC

Internal consistency was calculated from the results of the final trial of four pilot studies comprising 89 elementary teachers. All item-to-total score correlations were significant ($p < .01$). Kuder-Richardson formula 20 reliabilities were .81 for the I- subscale and .71 for the I+ subscale.

Teacher Role Survey (TRS)

The TRS scale (Maes & Anderson, 1985) includes 24 forced-choice items for which teachers report their perceived power in their role as teachers. Each item has two stems representing the alternate loci of control. By design, scoring is 1 point for the external response only. However, the scoring was reversed in this study; the internal scores were totaled so that the value for TRS locus of control would be consistent with the TLC value of locus of control. The range of scores possible is from 0 to 24.

Validity of the TRS

Anderson and Maes (1986) report criterion-related validity for the TRS which is supported by 1) a significant positive correlation ($r = .31; p < .01$) between the TRS and the Rotter I-E scale (Rotter, 1966); 2) a significant negative correlation—as predicted—($r = -.27; p < .01$) between the TRS and the Responsibility for Student Achievement (RSA) Total (Guskey, 1981); and 3) a significant positive correlation between the TRS and four symptoms on the Symptom Questionnaire (Kellner & Sheffield, 1973): anxiety—$r = .31$, $p < .005$; depression—$r = .35$, $p < .001$; hostility—$r = .28$, $p < .01$; and Total Symptoms—$r =. 34$, $p < .001$.

Reliability of the TRS

Maes and Anderson report alpha reliability estimates of .87 (1985) and .85 for the original 32-item version of the TRS. A two-week interval test-retest reliability was estimated at .75.(1986). The estimated alpha reliability reported for the revised 24-item TRS, as was used in this study, was .84 (1986).

Sample

The sample comprised 167 undergraduate students who were in the penultimate year of their preservice training. The group was randomly divided in half with the only distinction being that each group used a different form of locus of control measure. Two locus of control measures were used because it was felt that locus of control ought to be predictive of teachers' computer use and while these two measures overlapped they were distinct in the situations they addressed. Because of the time required to administer both, it was decided to only administer one to each half.

The undergraduates elementary education majors were selected since as future elementary school teachers, they should be teaching a variety of subjects and not be influenced to use computers by subject matter which naturally use computers. For example, secondary school teachers typically are subject matter specialists. Some subject areas such as mathematics or language arts may emphasize the use of computers; the teachers' use of computers in teaching may be largely influenced by the prevalence of the computers use in the subject area.

Results

Table 3 shows the distribution of the preservice sample by expected levels of computer use. Preservice undergraduate teachers were instructed to respond to the assessment items according to their *expected* level of computer use.

Table 3
Classification of Preservice Teachers by Levels of Expected Computer Use

Computer Use Levels	Preservice Teachers	%
Nonuse	4	2.7
Utilization	126	84
Integration	20	13.3
Total	150	100

Note. 17 cases were deleted due to missing values or because responses to the LU assessment were inconsistent.

Use: Of the 167 subjects participating, 17 were not eligible for classification of use according to the LU assessment—these were considered missing values. Of the 150 subjects classified for use, there were 4 who did not expect to use computers at all for teaching. The majority—84%—were classified at the Utilization level, and 13% were classified at the Integration level. The question raised is what their levels of use will be at the subsequent phases of their careers. For a comparison with the levels of use of practicing teachers see Marcinkiewicz (1991); it was found that the levels of use were inconsistent with the expected levels of use of the preservice teachers.

The descriptive data reported in Table 4 includes the mean, standard deviation, minimum and maximum values for each variable as well as the mode, percentage and the count of the mode.

Descriptive Statistics

Table 4
Descriptive Summary

variable	min	max	mean	*s.d.*	mode	%	count out of 167
age	20	41	22.7	4.2	20–23	85	142
gender					female	92	154
experience	0	13	2.9	2.1	2–4	38.9	65
innovativeness	34	70	53.9	7.4	50–55	28.1	47
locus of control	26	71	50	10	45–52	26.3	44
perceived relevance	1	7	6.05	1.1	6–7	79	132
self-competence	1	7	5	1.5	6	35.3	59

Note. Mean values were substituted for any missing values so that correlations were computed for all respondents including those whose responses to the LU assessment were inconsistent.

Four of the predictor variables, are age, gender, perceived relevance, and self-competence are relatively uniform—they have little variation. This was anticipated for this sample regarding age and gender. Eighty-five percent of the sample was between the ages of 20 to 23 and 92% was female. Future observations will bear little information regarding the influence of gender. However, any change in computer use for the group as a result of chronological aging might be quite informative.

It is noteworthy that the sample rather uniformly tended towards a perception of high relevance of computers to teaching (perceived relevance) and a perception of high likelihood of the ability to use computers competently for teaching (self-competence).

The mean of years of computer experience was 2.9 (*s.d.* = 2.12) with a range of 0 to 13. The mean score for innovativeness was 53.93 (*s.d.* = 7.4) with a range of 34 to 70. The two teacher locus of control measures (TRS and TLC) were standardized to T-scores. This was done because the entire sample used identical questionnaires except that half were randomly administered questionnaires which included the TRS and the other half were randomly administered the TLC.

Correlations were computed for both halves as well as logistic regressions to determine if either locus of control measure was related to use. The correlation of the TLC to use was $r = .16$; $p = .14$. The correlation of the TRS to use was $r = .09$; $p = .37$. In a stepwise logistic regression, neither measure of teacher locus of control was identified as a predictor for its respective half of the sample. Since the measures of locus of control were neither significantly correlated to use nor were they identified as predictors of use and because they had differing scales, the teacher locus of control values were standardized to T-scores and the reported correlations and logistic regression were computed for the entire sample. The T-score mean was 50 and the *s.d.* was 10.

Intercorrelation of all variables were computed. (See Table 5). The two variables that resulted in moderate and statistically significant correlations to use were perceived relevance and self-competence—$r = .28$; $p < .01$ and $r = .23$ $p < .05$ respectively. These two variables are complements derived from expectancy theory.

Table 5
Intercorrelations of All Variables in the Analysis

	use	age	gender	comput. exp.	innovat.	locus of control	perceiv'd relev'nce	self-comp.
use	—							
age	-.098	—						
gender	.121	.042	—					
computer experience	.094	-.087	.208	—				
innovativeness	-.011	.08	-.119	-.033	—			
locus of control	.125	.047	-.081	.091	.242 *	—		
perceived relevance	.28 **	.034	.081	.319 **	.059	.073	—	
self-competence	.23 *	.138	.106	.264 *	.07	.022	.376 ***	—

*$p < .05$; **$p < .01$; ***$p < .001$

Other statistically significant correlations were years of computer experience with perceived relevance ($r = .319$; $p < .01$); and years of computer experience with self-competence ($r = .264$; $p < .05$). Innovativeness was correlated to the standardized locus of control values which assessed for internal locus of control ($r = .242$; $p < .05$).

The correlation between perceived relevance and self-competence was strongest ($r = .376$; $p < .001$). This relationship may support the theorized complementary nature of these two variables. ($n = 167$ for all variables except use, average values were included for one case missing in each of age, gender, locus of control, and innovativeness)

A logistic regression was computed to explore the possible predictiveness of these variables to *use*. The two variables identified as predictive were perceived relevance and self-competence.($R = .27$; $p < .05$ and $R = .22$; $p < .05$).

Future Plans

Because perceived relevance and self-competence were computed to be most highly correlated with computer use and because their complementary nature is supported by expectancy theory, a more precise investigation of them and their relationship to computer use will be undertaken in the upcoming phases of this study. A measure of self-efficacy in computer use has been identified. A measure of perceived relevance is being developed.

Teacher locus of control may not be assessed in the future phases for two reasons. First, none of the teacher locus of control scales—the TLC or the TRS—either individually or as combined values standardized in T-scores were strongly or significantly correlated to *use*. Secondly, locus of control together with stability is a dimension of the construct of self-efficacy. The construct underlying the measure of self-competence is related to the construct of self-efficacy. Therefore, it is anticipated that assessment of self-efficacy will encompass locus of control as well.

We plan to control for the influence of environmental factors. In the future phases of the study when the subjects will actually be professional teachers, some effects of the environment will be controlled by limiting the subjects' eligibility for participation in the study by specifying maximum pupil-computer availability ratios at their respective schools. The planned for maximum pupil-computer availability ratio is 44–1 following the precedent of Marcinkiewicz (1991). That had been based on national averages from 1987 (OTA). However, given the increased availability of computers in education, the availability ratio may be halved; so that, in order for a teacher to participate in the study, the teacher will have to work in a school where there is at least one computer available for no more than 22 children. There is however, an aspect of the environment that has not been included in this study but which has been proposed in the theory of planned behavior (Ajzen, 1985). That is, the element of *subjective norms* which, briefly, means one's perception of the expectations of one's environment. Including this variable may be informative and it will complement the variables currently assessed.

Conclusion

An overwhelming percentage of preservice teachers seems to expect to use computers for teaching if at least at the utilization level. The two variables of "perceived relevance" and "self-competence" emerged as being statistically significantly correlated with and as predictors of computer use . This result is congruent with expectancy theory of which these variables are components. The results have encouraged us in our examination of these variables in relation to computer use by teachers.

REFERENCES

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl and J. Beckman (Eds), Action-control: From cognition to behavior, (pp. 11–39). Heidelberg: Springer.

Bandura, A. (1982). Self-efficacy mechanism in human agency. American Psychologist, 37, 122–147.

Bandura, A. (1989). Human agency in social cognitive theory. American Psychologist, 44, 1175–1184.

Becker, H. J. (1987). The impact of computer use in children's learning: What researchhas shown and what it has not (Report No. 18) Baltimore, MD: The Johns Hopkins University, Center for Research on Elementary and Middle Schools.

Berman, P. & McLaughlin, M. W., (1977) Federal programs supporting educational change, Vol. II:Factors affecting implementation and continuation. Santa Monica, CA: The Rand Corporation.

Bjerklie, D. & Hollis, R. W. (1991, May 20). The revolution that fizzled. Time. pp. 48–49.

Coovert, M. D., & Goldstein, M. (1980). Locus of control of users' attitude toward computers, Psychological Reports. 47, 1167–1173.

Crocker, L. & Algina, J. (1986). Introduction to classical and modern test theory. New York: Holt, Rinehart, and Winston.

Dambrot, F. H., Watkins-Malek, M. A., Silling, S. M., Marshall, R. S., & Garver, J. A. (1985). Correlates of sex differences in attitudes toward and involvement with computers. Journal of Vocational Behavior, 27, 71–86.

Dronka, P. (1985). Computer integration into instruction is stuck: Experts blame unclear optimal uses and three implementation problems. ASCD Update. 27(5), 1–8.

Ely, D. P., & Plomp, T. (1988). The promises of educational technology. In B. Branyan-Broadbent & R. K. Wood (Eds.), Educational media and technology yearbook 1988, 5–18. Englewood, CO: Libraries Unlimited.

Festinger, L. (1962). A theory of cognitive dissonance (2nd reissue). Stanford, CA: Stanford University Press.

Gagné, R. M. (1985). The conditions of learning and theory of instruction (4th ed.). New York: Holt, Rinehart, & Winston.

Gallo, D. D. (1986). Expectancy theory as a predictor of individual response to computer technology. Computers in Human Behavior, 2, pp. 31–41.

Gilbert, T. F. (1978). Human competence: Engineering worthy performance. New York: McGraw Hill.

Goldman, R. D., Kaplan, R. M. & Platt, B. B. (1973). Sex differences in the relationship of attitudes toward technology to choice of field of study. Journal of Counseling Psychology, 20, 412–418.

Guskey, T. R. (1981). Measurement of the responsibility teachers assume for academic successes and failures in the classroom. Journal of Teacher Education, 32, 44–51.

Hurt, H. T., Joseph, K., & Cook, C. D. (1977). Scales for the measurement of innovativeness. Human Communication Research, 4, 58–65.

Jorde-Bloom, P. & Ford, M. (1988). Factors influencing early childhood a dministrators' decisions regarding the adoption of computer technology. Journal of Computing Research, 4(1), 31–47.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), Instructional-design theories and models: An overview of their current status. Hillsdale, NJ: Lawrence Erlbaum.

Kellner, R. & Sheffield, B. F., (1973). A self-rating scale of distress. Psychological Medicine, 3, 88–100.

Maes, W. R. & Anderson, D. E. (1985). A measure of teacher locus of control. Journal of Educational Research, 79(1), 27–32.

Manning, M. M. & Wright, T. L. (1983). Self-efficacy expectancies, outcome expectancies, and the persistence of pain control in childbirth. Journal of Personality and Social Psychology, 45, 421–431.

Marcinkiewicz, H. R. (1991). The relationships of selected personological variables to the use of available microcomputers by elementary school teachers. Doctoral dissertation, The Pennsylvania State University.

National Task Force on Educational Technology. (1986). Transforming American education: Reducing the risk to the nation, a report to the Secretary of Education, United States Department of Education. T.H.E. Journal, 14(1), 58–67.

Nunnally, J. C. (1959). Tests and measurements: Assessment and prediction New York: McGraw-Hill.

O'Neill, J. (1990). Computer 'Revolution' on hold: Despite scattered progress, few signs of broad-based changes seen. ASCD Update. 32(9), 1–5.

Phares, E. J. (1976). Locus of control in personality. Morristown, NJ: General Learning Press.

Rieber, L. P. & Welliver, P. W. (1989) Infusing educational technology into mainstream educational computing. International Journal of Instructional Media, 16 (1), 21–32.

Roblyer, M. D. (1988). The effectiveness of microcomputers in education: A review of the research for 1980–1987. T. H. E. Journal, 16(2), 85–89.

Rogers, E. M. (1962). Diffusion of innovations. New York: The Free Press of Glencoe.

Rogers, E. M. (1983). Diffusion of innovations (3rd ed.). New York: The Free Press of Glencoe.

Rogers, E. M. & Shoemaker, F. F. (1971). Communication of innovations: A cross-cultural approach. New York: The Free Press.

Rose, J. S. & Medway, F. J. (1981). Measurement of teachers' beliefs in their control over student outcome. Journal of Educational Research, 74(3), 185–190.

Rose, J. S. & Medway, F. J. (1982). Measurement of teachers' beliefs in their control over student outcome [Erratum]. Journal of Educational Research, 75(3), 188–189.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 80 (1, Whole No. 609).

Rotter, J. B. (1975). Some problems and misconceptions related to the construct of internal versus external control of reinforcement. Journal of Consulting and Clinical Psychology, 43, 56–67.

Shanker, A. (1990, September 23). Equipping teachers for productivity: From chalkboards to computers. The New York Times, (Section E), p. 7.

Sheingold, K. & Hadley, M. (1990). Accomplished teachers: integrating computers into classroom practice. New York: Bank Street College, Center for Technology in Education.

Solomon, G. & Gardner, H. (1986). The computer as educator: Lessons from television research. Educational Researcher, 15(1) 13–19.

Suen, H. K. (1990). Principles of test theories. Hillsdale, NJ: Erlbaum.

Taylor, K. M. & Popma, J. (1990). An examination of the relationships among career decision-making self-efficacy, career salience, locus of control and vocational indecision. Journal of Vocational Behavior, 37, 17–31.

U. S. Congress, Office of Technology Assessment, Power on! New tools for teaching and learning, OTA-SET-379, Washington, DC: U.S. Government Printing Office, September, 1988.

Vroom, V. H. (1964). Work and motivation. New York: Wiley and Sons.

Welliver, P. (1990). Instructional transformation: A model for change. (The Pennsylvania State University Regional Computer Resource Center report to the other state centers and member teachers). State College, PA: Regional Computer Resource Center at the Pennsylvania State University.

Witteman, H. (1976). The relationship of communication apprehension to opinion leadership and innovativeness. Unpublished master's thesis. Department of Speech Communication, West Virginia University, Morgantown.

Title:

Narrative and Episodic Story Structure in Interactive Stories

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Introduction

An exploratory study was conducted examining children's responses to interactive, nonlinear HyperCard stories and the children's design of their own stories in HyperCard on the Macintosh computer. Twenty three fifth graders took part in a language arts training program that included HyperCard as well as traditional stories in books. The question was posed: How does HyperCard affect children's understanding of story structure? What happens when the conventions of story --- beginning, middle, end --- are transformed into a nonlinear form? This is an important issue since the research on reading and text comprehension shows that learners who understand the conventions of story structure are better able to understand the text and learn to read and comprehend more effectively than their peers who do not understand story structure (Gage and Berliner, 1988).

Study Overview

In this study, a semester-long language arts training program utilizing HyperCard was implemented with a group of 23 fifth graders. This program consisted of three components. First, the children were introduced to a variety of children's literature read to them by the university researcher. The researcher explained the characteristics of story structure and the components of stories, such as characters and plot and discussed the story characteristics for the stories she read with the children. Second, the children were introduced to HyperCard through the *Amanda Stories* (Goodenough, 1987) which are nonlinear narratives told through a series of pictures that include simple animation and sound effects, but virtually no written text. The computer sessions, with children working in cooperative pairs, were recorded on video. The children "talked through" the stories and after completing one of the *Amanda Stories*, the children were asked to discuss the story structure and story features and to compare the story to book-based stories. In the third and final part of this project, the children wrote and illustrated their own stories which were adapted to HyperCard.

The *Amanda Stories* are interactive narratives told through a series of pictures that include simple animation and sound effects, but virtually no written text. To move a story forward using HyperCard, the children used a mouse to control the cursor on the screen and to click on "hot spots" hidden within each picture. Since more than one hot spot is hidden within many of the pictures appearing on the screen, there are a variety of possibilities for plot development. The *Amanda Stories* are similar in nature to wordless picture books. These stories, including "Your Faithful Camel Goes to the North Pole" and "Inigo at Home" provided the children with a basic understanding of HyperCard and its possibilities for storytelling and story writing. HyperCard is a tool for designing and accessing information flexibly and in a nonlinear fashion on the Macintosh computer. To move a story forward using HyperCard, the children used a mouse to control the cursor on the screen and to click on "hot spots" hidden within each picture, or card. Since more than one hot spot is hidden within many of the pictures appearing on the screen, there are a variety of possibilities for plot development.

The children were encouraged to write fully-formed stories on topics inspired by a variety of children's literature read to them by the university researcher. An additional source of inspiration for these fifth graders were the *Amanda Stories*. While creating their own HyperCard stories, the children used their problem solving capabilities. The childen composed their stories with pen and paper and then their writing was transferred to word processing files using the computer. All of the children were given total access to the composing process, brainstorming topics for writing, sharing their work in progress, and ultimately editing their stories before publication. The children created illustrations for their stories, using pencil and paper, and these illustrations were scanned into the computer and then placed into HyperCard computer stacks. Thus the children's HyperCard stories consisted of a sequence of drawings with "hot spots" linking them.

At the end of the project, the children had the opportunity to view one another's HyperCard stories via a liquid crystal display overhead projector linked to a Macintosh computer. Needless to say, the children were filled with a sense of excitement and self-satisfaction seeing the results of their work. These stories were compiled in book form in *Super HyperCard Computer Stories;* this book includes both the written stories and printouts showing the cards or pages of illustrations in the HyperCard stacks. This is a unique collection of narratives written and illustrated by 23 fifth graders during their very first introduction to HyperCard.

Methods

The research methods used in this qualitative study included: 1) taking notes on class discussion and student questions concerning the story structure of stories read out loud from books; 2) observation of student pairs working through the *Amanda Stories* on the computer and related interviews with students; and 3) evaluation of student stories, both text and pictures.

Students worked through the *Amanda Stories* in pairs. They were directed to take turns using the mouse and "talking through" the story as it unfolded on the computer screen. The researchers observed the the sessions on the computer and these sessions were videotaped for later analysis. All students were observed as they worked through both "Your Faithful Camel Goes to the North Pole" and "Inigo At Home!" After the pairs of students had completed each story, they were asked a set of questions concerning story structure, including: (1) retell the story; (2) describe the main characters; (3) what was your favorite part of the story?; (4) were there any differences between this story and the stories that were read out loud in class?; (5) was there any special message?; (6) how did this story make you feel?; (7) did this story give you any ideas for writing stories of your own?

Discussion

This discussion of the research results will focus on the children's responses to the *Amanda Stories* and their observed interactions with the stories. The two Amanda Stories that were used with the fifth graders provided a valuable contrast. The first, "Inigo at Home," consisted of a series of incidents that did not occur in any particular order, although the story always starts at the same point. In the second story, "Your Faithful Camel Goes to the North Pole," the events clearly had a fairly linear order and the "story" had an outcome, stated in the story's title: the camel and its companion were trying to get to the North Pole. In most screens or frames in this story, the North Pole could be seen in the distance, a reminder of the destination or goal. The children responded differently to the two HyperCard stories.

As they went through "Your Faithful Camel Goes to the North Pole," the children were very focused on getting to the North Pole. In some instances, they were frustrated when they were taken off on what they perceived as a detour from the main story; for example, when the camel builds an igloo out of ice where the two travellers spend the night, or some of the embellishing details that take place at the reindeer's house right before the final leg of the journey. Most students reported that their favorite part of this story is the sleigh ride down the North Pole at the very end of the story.

By contrast, with "Inigo at Home," since there was no clear-cut goal or plot, the children were happy to explore the embellishing details, such as sounds and simple animation sequences. They did not view these details as detours taking them away from the main line of the narrative. Instead, the children perceived the challenge with this story to be the discovery of all the possible details of action, graphics and sound. For example, they took great delight with a spider that lowers itself down from the edge of a picture frame, prompted by the click of a mouse. With this story, the students were working through the stack in a manner that was more in keeping with the premise underlying HyperCard: the availability of powerful nonlinear linkages. The story "reader" doesn't need to always go through the story the same way; instead the "reader," or learner, has control of a rich array of options.

How do HyperCard stories compare with traditional stories? Bolter (1991) suggests that hypertext systems such as HyperCard offer a new type of narrative structure, based on episodes, which creates a new kind of story rhythm. According to Bolter,

> The episodes may be paragraphs of prose or poetry, they may include bit-mapped graphics as well, and they may be of any length. Their length will establish the rhythm of the story --- how long the reader remains a conventional reader before he or she is called on to participate in the selection of the next episode. At the end of each episode, the author inserts a set of links to other episodes together with a procedure for choosing which link to follow. Each link may require a different response from the reader or a different condition in the computer system. (p. 122).

Instead of a structure of beginning, middle and end that characterizes traditional stories, hypertext stories are designed around the more flexible structure of episodes. In the study reported here, the two Amanda Stories that were featured, "Your Faithful Camel Goes to the North Pole" and "Inigo At Home!", provide a contrast between these two structures. "Your Faithful Camel Goes to the North Pole" retains a more traditional story structure where there is clearly a beginning, middle, and end, whereas "Inigo At Home!" features an episodic structure. At the same time, both of these stories are built upon episodes. Furthermore, both of these stories are fairly simple in structure, largely due to the fact that they are made up almost entirely of pictures.

A contrasting story form can be found in the *Discis* stories, including "Cinderella" and A "Long Hard Day at the Ranch," in CD-ROM format designed to be interfaced with the Macintosh computer. The *Discus* story series on CD-Rom are interactive stories that incorporate hypertext features. These stories are very traditional linear narratives but they are designed to offer a wealth of different "levels" of information, such as spoken word definitions or a spoken identification of an object in an illustration, when the mouse is clicked.

The question of how HyperCard affects children's understanding of story structure is a very important issue since the research on reading and text comprehension shows that learners who understand the conventions of story structure are better able to understand the text and learn to read and comprehend more effectively than their peers who do not understand story structure (Gage and Berliner, 1988). The research on reading suggests that what the text presents is important, but perhaps more important is what the reader brings to a learning situation. Without rich schemata for incorporating the text, not much will be learned. For example, cognitive studies show that students who do not have a schemata for a story often cannot remember stories well. Gage and Berliner (1988) explain:

> Some children enter school with sophisticated ideas about the nature of stories. They know, for example, that stories have beginnings and ends, are usually presented in chronological order, have a hero or heroine, put an obstacle in his or her way, and arrive at a solution to a problem. A child without a story scheme is at a disadvantage. Even if this child could decode every word as well as someone who has a well developed story schema, he or she would probably be found to comprehend less when tested. Reading, then, is more than decoding. There is no doubt that teaching decoding and word recognition skills --- a practice prevalent in schools --- is helpful in making reading more automatic. But reading now is seen also as a sense-making process, with meaning at its core. (p. 307)

Strategies for remedial reading, based strictly on having children read bits and pieces of sentences or do worksheets often devoid of meaning are probably emphasizing the wrong thing. These strategies are much less valuable to remedial readers than is learning to understand the underlying structure (Gage and Berliner, 1988).

One implication of this research on reading and text comprehension is that learners often need reinforcement in understanding, and searching out, the underlying structure of any material they are presented with, whether in book or hypertext format. Without an understanding of the structure of traditional text, learners are at a further disadvantage in approaching the potentially more sophisticated structure of hypertext. In this study, the researcher explained the characteristics of stories and discussed the story characteristics for all the stories presented to the children, including both those read out loud from books and the Amanda stories in HyperCard on the computer. Thus, it is recommended that in introducing learners to HyperCard stories, teachers present activities that help learners think about, and practice using, the structural features of stories.

Stories provide a familiar, comprehensible structure for children encountering the nonlinear capabilities of hypermedia for the first time. And stories provide valuable design guidelines for hypermedia designers (McLellan, in press). Stories set up an expectation at the beginning, which is elaborated or complicated in the middle, and satisfied at the end. "Stories are linked beginning to end by the establishment of an expectation in the beginning that is satisfied in the end. Thus, good stories are characterized by a powerful principle of coherence. Stories hold their power over us as long as all the events stick to and carry forward the basic rhythm (Egan, 1986)." Thus, the implication for hypertext design is that the information, the lesson should be organized coherently and meaningfully, with no extra baggage --- at least in the initial presentation. This suggests that selection and organization are more more important than comprehensiveness.

The combination of stories and instruction in a HyperCard environment remains to be fully explored. However, the results of this study highlight children's great enthusiasm for this kind of interactive story. These results also point out that a new computer-based story structure is in the early stages of development. Further research is needed, both in terms of how the story structure can be adapted to take advantage of the capabilities of HyperCard and also in conceptualizing new more active roles for learners encountering stories. Alessi & Trollip (1985) suggest that in any lesson, it may be valuable to encourage the students to envision themselves in a situation where they can really use the information they are learning: stories can help to encourage this visualization, especially as the learners, in the role of explorers or detectives, become part of the interactive story. One type of explorer role is the examination of story structure and features. Another role is as story creator. Both of these roles were featured in this project.

Conclusions

The study reported here suggests that children can adapt to the new story structure offered by HyperCard. However, in introducing children to HyperCard, it is valuable to provide training concerning the features of story structure so that children have a firm understanding of structural features when they explore a new type of story structure. Also, it is beneficial to have students practice designing stories for the hypertext medium, as was done in this study.

One implication is that learners often need reinforcement in understanding, and searching out, the underlying structure of any material they are presented with, whether in book or hypertext format. Without an understanding of the structure of traditional text, learners are at a further disadvantage in approaching the potentially more sophisticated structure of hypertext.

Another implication is that it might be valuable to design explorations to help learners think about, and practice using, the structural features of stories (Bromley, 1991; McLellan, in press). The hypertext program can be designed so that the learner explicitly examines story structure, together with the structure of the content domain and the way it is presented.

Future Research

The next stage of this study will be to develop HyperCard-based episodes that are somehow linked, featuring both pictures and text, and having the learners organize them into interactive sequences that make sense to them, including possible additions they may wish to include. Models of an episodic structure include most of Woody Allen's movies (Radio Days, Manhattan, etc.) and also the movie Mystery Train by director Jim Jarmisch (Rosenblum & Karen, 1986). In this proposed research, students will be encouraged to make as many linkages as possible, and to build on what they have learned about story structure.

References

Alessi, S. M., & Trollip, S. R. (1985). Computer-based Instruction: Methods and Development. Englewood Cliffs, NJ: Prentice Hall.

Baecker, R., & Small, I. (1990). Animation at the Interface. In B. Laurel (Ed.). The Art of Human-Computer Interface Design. Reading, MA: Addison Wesley.

Bolter, J.D. (1991). Writing Space: The Computer, Hypertext, and the History of Writing. Hillsdale, NJ: Lawrence Erlbaum Associates.

Bromley, K.D. (1991), Webbing with Literature: Creating Story Maps with Children's Books. Boston, MA: Allyn and Bacon.

Discis Books (1990). Cinderella. [CD-ROM disc].

Discis Books (1990). A Long Hard Day at the Ranch. [CD-ROM disc].

Egan, K. (1986). Teaching as Storytelling: An Alternative Approach to Teaching and Curriculum in the Elementary School. Chicago, IL: University of Chicago Press.

Gage, N.L., and Berliner, D.C. (1988). Educational Psychology. Boston: Houghton Mifflin Co.

Goodenough, A. (1987). Amanda Stories. Santa Monica, CA: Voyager Company. [Computer Software].

Greenberger, M. (Ed.). (1990). On Multimedia: Technologies for the 21st Century. Santa Monica, CA: The Voyager Company.

McLellan, H. (In press). Hyper Stories: Some Guidelines for Instructional Designers. Journal of Research on Computing in Education.

Rosenblum, R., & Karen, R. (1986). When the Shooting Stops...The Cutting Begins: A Film Editor's Story. New York: Da Capo Press.

Title:

Instructional Analogies and the Learning of Tangible and Intangible Concepts

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Instructional Analogies and the Learning of Tangible and Intangible Concepts

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An instructional analogy has been defined as an explicit, nonliteral comparison between two objects, or sets of objects, that describes their structural, functional, and/or causal similarities (Stepich & Newby, 1988b). An example includes: A red blood cell is like a truck in that they both transport essential supplies from one place to another through a system of passageways.

Commonly utilized as instructional tools (e.g., Curtis & Reigeluth, 1984), analogies have been employed to teach a variety of subjects, including science (Cavese, 1976; Last, 1985; Scheintaub, 1987), computer programming (Rumelhart & Norman, 1981), composition (Ledger, 1977), and creative problem solving (Gordon, 1961). In a particularly innovative application, Nichter and Nichter (1986) taught rural villagers in India principles of health and nutrition by likening them to more familiar principles related to planting and tending crops. Their purpose is to allow relational information to be mapped from a source known to the learner to one that is unknown (Vosniadou & Schommer, 1988).

Instructional analogies have been shown to consist of four basic components: (a) the target domain (or subject); (b) the base domain (or analog); (c) the connector; and (d) the ground (ref.). The target domain refers to the new to-be-learned information. From the previous example, the target would be the red blood cell. The base domain (truck, from the example) consists of information familiar to the learner which will be used to make a comparison. The connector is a verb phrase, such as is like, which establishes the nature of the relationship between the base and target domains (Rumelhart & Norman, 1981). Finally, the ground is a detailed description of the similarities, and possible differences, indicated by the connector. It is represented by the phrase, transport essential supplies from one place to another through a system of passageways.

Theories of analogical transfer have been developed to explain how information from a base domain is used to facilitate the understanding or manipulation of information in another unrelated target area (Gentner, 1982; 1983; 1988; Gentner & Toupin, 1986; Holyoak, 1984; 1985) In most cases, analogical transfer has come to be viewed as a process of "second order modelling" (Holyoak, 1985) in which a model of the base is used to progressively develop a model for the target. This process takes place through the mapping of a limited set of properties between the domains. Central to this conceptualization is that prior knowledge, which is organized and stored in the learner's memory, serves as a framework or "assimilative context" for the acquisition of new knowledge (Glass & Holyoak, 1986; Mayer, 1979).

Although analogies have been frequently utilized and have become integral parts of accepted theories of instructional design (e.g., Reigeluth & Stein, 1983), research to this point has been divided in terms of their effectiveness for the comprehension and retention of concepts. Drugge and Kass (1978), for example, found that verbal analogies did not significantly increase immediate comprehension. Gabel and Sherwood (1980) in a year-long study of analogies within a high school chemistry curriculum demonstrated no significant improvement on chemistry achievement. Likewise, Bean, Singer, and Cowen (1985) found analogies were not effective with above average students.

With these inconsistent findings the limitations of the analogies and their parameters for effective learning should be investigated in order to successfully predict when their use would be beneficial within a particular instructional setting. To date, a number of factors have been identified. The first, and most prominent, is the learners' comprehension of the analogy used to teach the new content. In the Gabel and Sherwood (1980) study, analogies were not helpful to all students. However, it was shown that as many as 48% of the subjects did not fully understand the analogies used to teach the content. Of those that did understand, scores on the semester achievement tests were significantly higher. Similar results were found in later studies designed to identify difficulties in chemistry problem solving (Gabel & Samuel, 1986; Gabel & Sherwood, 1984).

A second limitation of analogies is the tendency to overgeneralize. Overgeneralization refers to the tendency to include things in a category when they, in fact, don't belong. Schustack and Anderson (1979), for example, asked subjects to read and recall brief biographies of fictional characters. When asked to identify statements they had seen before, subjects showed a higher frequency of false recognitions when the fictional biography was closely analogous to the life of a famous real person. In a recent study by Halpern, Hanson, and Riefer (1990) subjects receiving analogies which were designed from base domains significantly different than the target domains proved to be more successful than those derived from similar or near base domain subject matter. Their conclusions indicated that those from the far domain required additional depth of processing to successfully complete the structural mapping and thus the extra effort increased their abilities and subsequent performances.

Another interpretation, however, could include that those from the near domain may have had increased numbers of mistakes due to overgeneralization.

Another limiting factor appears to be the time required to make use of analogies. Analogies are effective, but may not always be efficient as instructional aids. In two sets of studies, Simons (1982; 1984) noted that including an analogy in printed instructional materials increased recall and comprehension of newly learned information, but only under conditions of unlimited study time. Restricting the amount of time the subjects were given to read the materials reduced the advantage of the analogy based instruction. According to Simons, analogy based materials require more time because the additional information in the analogy must be read and compared to the other information in the text. This additional effort pays off in subsequent reading of the same materials, however. Learners can often reread text with analogies more rapidly than text without analogies because of the deeper conceptual understanding they gained from the first reading (Simons, 1984).

A final limiting factor is the learner's need for cues indicating the relationship between the information to be learned and its analog. Cueing is particularly important because learners do not always see the relationship between an analog and its target. As a result, they do not always use the analog when performing the target task (Gick & Holyoak, 1980; 1983). Reed, Dempster, and Ettinger (1985) tried a variety of cueing techniques to increase the transfer of information between algebra word problems. These included describing the relevancy of the analog, making the analog solution available while solving the target problem explaining why a particular equation was used to solve an analog problem, and matching the complexity of analog and target problems. Their failure to produce consistent results demonstrates the difficulty learners have in applying analogous information, even when its usefulness is highlighted.

As indicated by the previous studies, the emphasis on the study of analogies and their impact on learning has been focused on the analogy itself (i.e., how they are constructed, cued, and placed within the instructional materials). A second area of research however, should also extend to the type of to-be-learned concept or material within the target domain which is to be taught. Are analogies more or less effective when the to-be-learned concepts vary in difficulty, ambiguity, complexity, or abstractness? Newby and Stepich (1987) for example, have argued that abstract concepts are qualitatively different than concrete concepts in ways that make them more difficult to learn. An analogy, in their view, can facilitate learning an abstract concept by generating a "prototype substitute" that can represent the abstract concept in memory in much the same way that a prototype comes to represent a concrete concept in a concept learning task. Davidson (1979) has also described analogies as a way of translating abstract information into a form that is more concrete and imaginable and, therefore, more easily understood. According to Simons (1982; 1984) this is the "concretizing" function of analogies.

The concretizing function was demonstrated in a lesson designed by Iona (1982) to teach college students about electricity. The more abstract components of an electrical system were likened to the more concrete and imaginable components of a hydraulic system in which water flows from a hilltop reservoir to a mill at the bottom of the hill. For example, in the analogy electrical voltage was likened to the distance between the reservoir and mill; amperage was likened to the rate of water flow; and electrical resistance was likened to narrow pipes or anything else that will obstruct the flow of water. Other concretizing applications can be found in subjects as diverse as biology (Cavese, 1976) and political science (Russell, 1980).

The present study was designed to compare the effectiveness of instructional analogies given different types of concepts within a single target domain. Specifically, five concepts rated as highly tangible and five rated as highly intangible, all from the same content area of physiology, were selected for this study. Two groups of subjects received training involving all concepts. Training for one group included instructional analogies for each of the concepts; whereas, the training for the other group omitted the analogies. The main purpose of the investigation was two-fold: (a) to investigate if subjects given instructions with analogies comprehend and recall concepts more effectively than subjects who receive instructions without the analogies; and (b) to study the differential effects of analogies given tangible and intangible physiological concepts.

The design of this study also allowed for the investigation of several additional questions involving the use of analogies. For example, "Would an intervening period of time between training and additional testing affect the group performances?"; moreover, "Would there be a reported change in the degree of comprehension and recall based on concept type?"; "Would using analogies result in greater confidence in learning?"; "Would using analogies result in greater lesson enjoyment?"; and "Would the times required for initial learning and/or testing of the materials differ between the groups?".

Method

Subjects

Ninety four subjects (72 female, 22 male) from an undergraduate introductory educational psychology course at a major midwestern university were solicited to participate in the study. All subjects volunteered in order to meet a course requirement for participation in research. The participants' declared major fields of study included education (64.9%), humanities (14.9%) science (11.7%), and physical education (3.2%). Eight subjects failed to return for the two-week follow-up testing. These included six who had been assigned to the analogy group and two from the no-analogy group.

Instructional materials

Concept selection. Physiology was selected as the content area for the study based on the premise that it is a concept-rich subject that includes a range of concepts from the very tangible to the very intangible. Additionally, this subject matter was predicted to be highly unfamiliar to the target group of subjects. A physiology instructor from the Purdue University School of Veterinary Science and Medicine and two of his graduate assistants served as content experts for the development of the materials.

The content experts used their course textbook, Physiology: A Regulatory Systems Approach (Strand, 1983), to identify 611 potential target concepts. This list was reduced to 32 using the following rules: (a) concepts that labeled structures were eliminated while concepts that labelled processes were kept; (b) two word concepts were eliminated while one word concepts were kept; (c) concepts common in everyday language (e.g. salivation, respiration) were eliminated.

In order to make the final selection of concepts from this list of candidates, the 32 concepts were rated by 10 experts (professors, instructors, and advanced graduate students) from Purdue University's School of Veterinary Science and Medicine and the School of Science. Using a seven-point semantic differential rating instrument, each expert rated each of the 32 concepts (Kerlinger, 1973). Five concepts rated as the most tangible (ossification, parturition, micturition, adaptation, and peristalsis) and five rated as the most intangible (disinhibition, pinocytosis, adsorption, summation, and catabolism) were selected for the study.

Instructional materials development. The purpose of the development phase was to create the lesson, in analogy and no-analogy versions, that would be used to teach the concepts selected in the preceding stage. In its final form, the lesson included the following written materials: (a) an introduction and instructions; (b) instructional materials for each concept, including a definition, a one-paragraph description of the physiological process, a verbal analogy (for the analogy condition only), a posttest, and a follow-up questionnaire. The development and validation of the materials followed accepted instructional design principles (e.g., Dick & Carey, 1985).

The first step in creating the lesson was to meet with the content experts and construct an analogy for each of the selected concepts. Construction of the analogies followed the steps outlined by Stepich and Newby (1988b). For each concept, the feature most important to comprehension was identified and one or more concrete items having the same or a similar feature were listed. One of these concrete items, likely to be familiar to the learners, was then chosen as an analog. The analogy was completed by describing the similarities between the chosen analog and the concept. As an illustrative example, the feature most important to understanding the process of peristalsis is the progressive wave of muscular contraction propelling food through the digestive tract. Potential analogs included extracting toothpaste from a tube or squeezing ketchup out of a single-serving packet. Both analogs were expected to be familiar to the learners and the ketchup squeezing analog was chosen as the more accurate of the two. Peristalsis was then described in terms of the analog:

> "Peristalsis is like squeezing ketchup out of a single-serving packet. You squeeze the packet near one corner and run your fingers along the length of the packet toward an opening at the other corner. When you do this, you push the ketchup through the packet, in one direction, ahead of your fingers until it comes out of the opening."

This process was repeated for each of the other nine concepts. Each of the analog or base domains were selected based on two criteria: (a) their high degree of familiarity for the learners (Gabel and Samuel, 1986) and (b) they were from a different or far domain than the to-be-learned concepts (Halpern, et al., 1990).

Next, several physiology textbooks (Holmes, 1979; Jacob & Francone, 1965; Luciano, Vanden, & Sherman, 1983; Parker, 1984; Schmidt & Thews, 1983; Strand, 1983; Vanden, Sherman, & Luciano, 1983) were used as information sources and an initial draft of the lesson was written. This draft included an introduction to the study, a definition, description, and analogy for each concept, and a follow-up questionnaire. This draft was then evaluated by the content experts and two experienced instructional designers to ensure its accuracy, clarity, and appropriateness for the intended subject group. Suggestions obtained were incorporated into a second draft of the materials. The concept materials were again evaluated by the content experts and their suggestions were incorporated into a third draft.

At this point the content experts wrote a set of 20 multiple-choice test items (two items per concept). Each item was developed to focus on concept application, as opposed to simple recall. All test items were then ordered randomly. The test directions and items were then reviewed by an instructional designer and experienced teacher who had not previously seen the materials and who was not a content expert. This helped to ensure that the tests were clear and comprehensible. Evaluative comments were incorporated into a revised version of the test.

The follow-up questionnaire was next constructed. This consisted of questions to obtain bibliographic information (e.g., sex, age, academic major), a question asking the participant to estimate how many questions on the 20-item test they answered correctly, and a Likert-type rating scale to indicate their degree of enjoyment with the lesson.

The development of the materials was followed by a field test involving 24 subjects. Each was given a complete set of materials which included an introduction and set of instructional materials, a posttest, and a follow-up questionnaire. The instructional materials differed based on the independent variable; however, tests and questionnaires were identical for all subjects. Reliability scores, using the Kuder-Richardson formula (Mehrens & Lenman, 1984) indicated a posttest reliability of .68. Following suggestions given by the participants, the wording of several questions in the questionnaire was revised and the verbal instructions given to introduce the study were incorporated within the written instructions.

Procedures

For the formal investigation, subjects were allowed to sign up for one of three scheduled 90-minute periods. Each session was scheduled in a university classroom that could facilitate up to 50 students. Investigators monitored each experimental session and were given a set of procedures to follow. A digital clock was placed at the front of the room to provide consistent time to be recorded. When the subjects were seated the investigator briefly introduced the study and distributed the handout containing the introduction and concept lesson. This handout had been stacked alternating between analogy and no-analogy versions. The copies were then distributed by rows, effectively randomizing assignment to the two experimental conditions.

The concept lesson asked the subjects to note the last four digits of their social security number (for identification purposes) and to record the time they began studying the materials. After they had studied the concept materials for as long as they wished, they were again asked to note the time. The first handout was then returned to the investigator whereupon a copy of the posttest was received. All subjects received the same posttest. Subjects were asked to record the 4 digit identification code, as well as the starting and completion times of the test. No limits were given on the amount of time to finish the exam.

After the test was completed, subjects returned it to the instructor and they were given a copy of the follow-up questionnaire. Upon completion and return of the questionnaire each subject was reminded to return in 14 days at the same time and location. No further instructions were given and they were free to leave.

When the subjects returned in 14 days they were each given a second posttest. This test consisted of a short set of directions and the same 20 questions (in a new random order) of the initial posttest. Subjects were also asked to record their four-digit social security code number and the beginning and ending time of the test. No time limit was given for the test and it was returned to the investigator upon completion. All subjects were then debriefed and thanked for their participation.

Results

This investigation examined four dependent variables: comprehension of the concepts (both immediate and longer term); enjoyment of the lesson; confidence in learning; and time required to study the concepts and complete the posttests. In each case separate analyses were completed.

To compare the comprehension of the concepts across conditions, the 20-question immediate posttest was graded for each subject and the results were grouped based on method of instruction and type of concept. A mixed-factorial analysis of variance (method of instruction by type of concept with repeated measures) was performed on the mean number of items answered correctly for each concept. As shown in Figure 1, those subjects receiving instructions with analogies significantly outperformed those who did not receive the analogies ($\underline{F}$ (1,92) = 10.53; $\underline{MS}$ = 67.92; $\underline{p} < .002$). No significant difference was shown between the comprehension of the tangible and intangible concepts; however, a significant interaction ($\underline{F}$ (1,92) = 6.09; $\underline{MS}$ = 17.28; $\underline{p} < .02$) between the two independent variables was recorded. Figure 1 illustrates that those subjects in the analogy group performed at a slightly higher level given tangible concepts than they did given intangible concepts; whereas, those in the no-analogy group achieved a higher score given intangible concepts when compared with their scores for the tangible concepts.

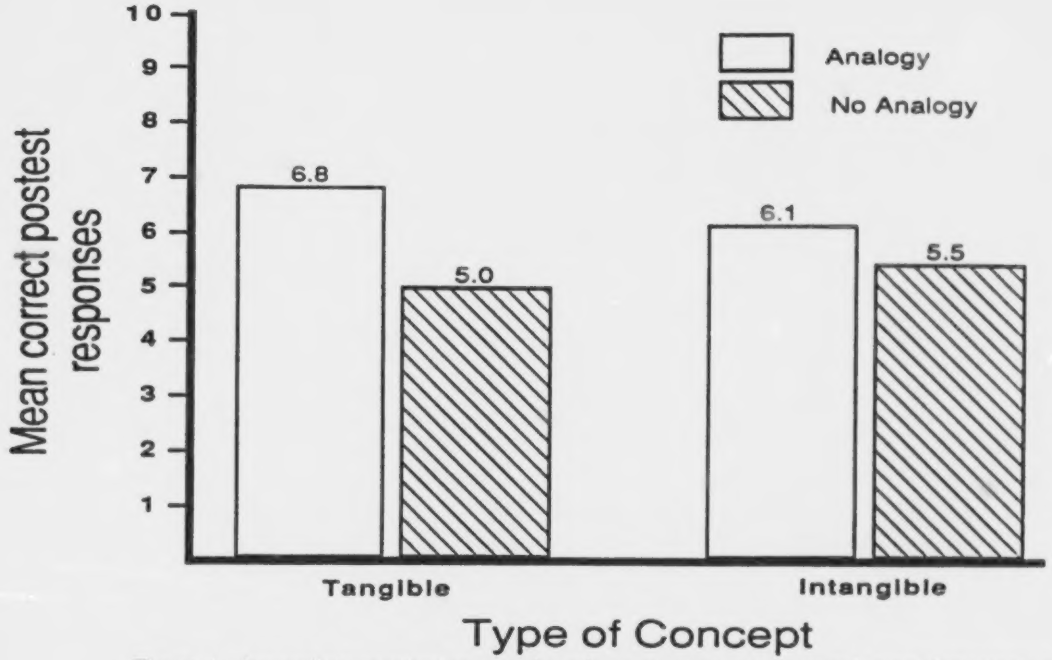

Figure 1. *Immediate posttest comprehension mean scores comparing analogy versus no-analogy trained subjects across tangible and intangible concepts.*

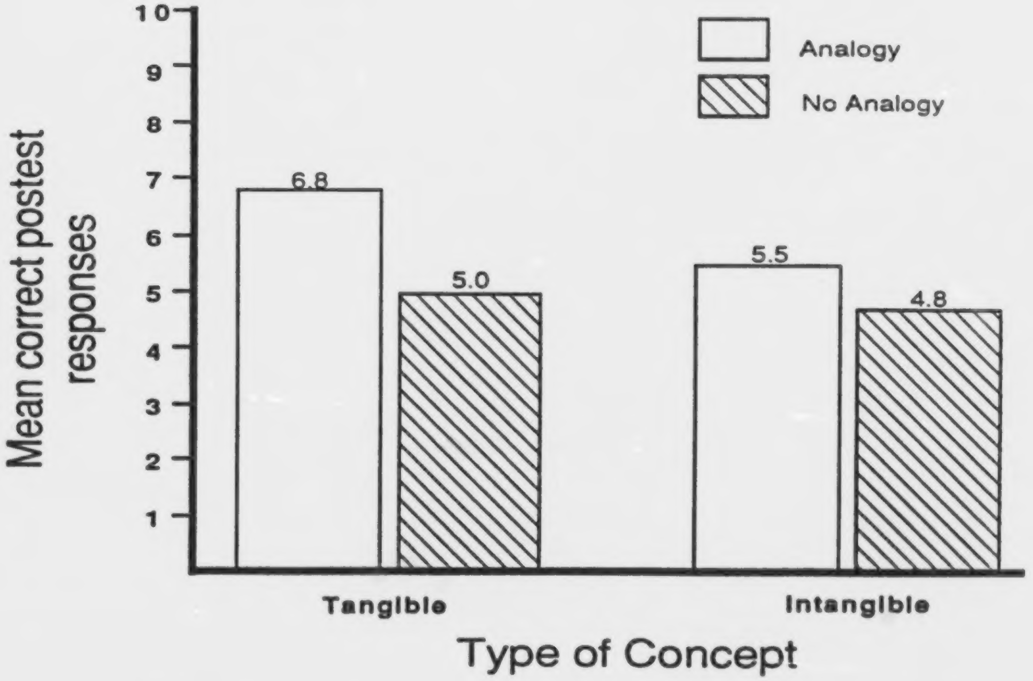

Figure 2. *Fourteen-day posttest comprehension mean scores comparing analogy versus no-analogy trained subjects across tangible and intangible concepts.*

The two-week posttest was examined in the same manner as that of the initial posttest. As shown in Figure 2, the two groups attained the same mean scores as reported for the initial posttest for the tangible concepts but decreased in their comprehension for the intangible concepts. A significant difference was again recorded based on the method of instruction as those receiving analogies significantly outperformed those not receiving such instructions (F (1,84) = 9.43; MS = 67.37; p < .003). In this case however, there was a significant difference between the tangible and intangible concepts (F (1,84) = 7.17; MS = 22.349; p < .009), but no significant interaction was reported.

Enjoyment of the lesson was measured by a single questionnaire item in which the subjects were asked to rate how much they had enjoyed the lesson on a scale from 1 (not at all) to 5 (a lot). A significant difference was found between the analogy (M = 3.02) and the no analogy (M = 2.59) conditions using a two-tailed t-test (t (92) = 1.869; p <.05).

Confidence in learning was measured by asking the subjects to predict how many items they felt they had answered correctly on the initial posttest. Means for the analogy and no-analogy conditions were 14.19 and 13.55 respectively. A two-tailed t-test indicated no significant difference between the analogy/no-analogy predictions.

In order to measure the final variable, time, all subjects were asked to record the time they started and finished both the lesson and the two posttests. The time spent, in minutes, was then tallied for the analogy and no-analogy conditions. Two-tailed t-tests were performed on the mean study times and the mean test times. A significant difference was found in the mean study times (t (92) = 1.953; p < .05) but not for either of the testing periods. The mean study times for the analogy and no-analogy conditions were 12.04 minutes and 10.55 minutes, respectively.

Discussion

From the measurement of the four dependent variables, comprehension, enjoyment, confidence, and time, several important findings should now be discussed. First, the results indicate that analogies had a beneficial effect on the comprehension of unfamiliar concepts. In other words, subjects who received instructions which included analogies scored significantly higher on the immediate posttest than those who did not receive training which included the analogies. Moreover, this difference in comprehension was sustained during the two-week posttest. Even though the learners were not prompted to recall or use the analogies in any way, comprehension scores indicate a difference between the two groups remained even after the 14-day interval. The use of analogies appears to be an effective instructional strategy which increases the immediate and long term comprehension of concepts.

Conclusions about the influence of analogies on the comprehension of different types of concepts in the present experiment are strengthened by the fact that the subjects in the analogy condition were neither trained in the use of analogies nor cued to use the analogies they were given. Gick and Holyoak (1980; 1983) and others (e.g., Reed, Dempster, & Ettinger, 1985; Schustack & Anderson, 1979) have shown that training and cueing are essential aspects of using analogies effectively in instruction. The subjects in the present experiment, however, were not given practice in using analogies or cues to use analogies in recalling the concepts for the test. In spite of this, subjects in the analogy condition outperformed subjects in the no-analogy condition on both posttests. This indicates that training and cueing may not be necessary and that analogies facilitate concept learning even when the subjects are neither trained nor cued. Additional research is needed to further explore the contribution training and cueing make to the effectiveness of analogical instruction as well as the best methods for providing such training and cueing.

A second relevant finding from this investigation was the degree of effectiveness of analogies based on the concepts being either tangible or intangible in nature. Although during the immediate posttest the analogy group significantly outperformed the no-analogy group given either type of concept, the analogy group showed no significant difference in the comprehension of the tangible versus that of the intangible concept types. This was not the case, however, after the 14-day interval had elapsed. In that instance, while the analogy group still significantly outperformed the no-analogy group for both types of concepts, the comprehension of the intangible-type concepts decreased significantly for both groups. Although the analogy instruction remained more effective, the concurrent decrease indicates the possibility of interference being greater for those concepts of a less tangible nature. Several authors have pointed out the differences between concept types and the increased difficulty of those of an intangible nature, however, further research focusing on the potential interference differences is needed (Newby & Stepich, 1987; Reed & Dick, 1968).

A final point that should be considered in the discussion of the concept-type differences is that of the interaction effect shown to occur during the initial posttest. As indicated in Figure 1, the no-analogy group initially scored higher for intangible concepts than they reported for the tangible concepts while the opposite was true for the analogy group. Such results by the no-analogy group contradict previous investigations as well as their own 14-day interval posttest results, and thus may be an indication of spurious results (Royer & Cable, 1976; Reed & Dick, 1968). However, this result may also be an indication of the overall effectiveness of the training. For each individual concept the learner received a definition and a description. It may be that those different training lessons for the intangible concepts were initially clearer or more readily understood. These conclusions are questionable however, because of similar effects not being revealed within the data from the analogy group and because of no interaction seen aftger the two-week interval.

A second factor measured during this investigation was enjoyment for the lesson as perceived by the learners. Following training and the initial posttest, all subjects were asked to rate the degree to which they enjoyed the lesson. The results indicate the use of analogies positively influenced the subjects' rated enjoyment of the lesson. That is, analogies may be valuable in instruction because they increase the learners' enjoyment of learning. Keller and Kopp (1987) and Newby (in press) have pointed out that familiarity helps learners see the relevance of what they are learning which increases their motivation to learn. Analogies connect new concepts to familiar objects and events and, thus, may increase the learners' motivation by increasing the relevance of the instruction. The strength of this conclusion is limited, however, because it is based on a single subjective measure. Additional research is needed to explore the effects of using analogies on more objective measures of enjoyment.

The third variable measured the perceived confidence subjects had in their comprehension of the concepts. The results show that using analogies did not affect the subjects' confidence in their learning. This is contrary to what might be expected, especially in light of the observed differences in comprehension between subjects in the analogy and no-analogy conditions. One possible explanation for this result is that the subjects perceived the concepts as so difficult that they saw little chance of success, even with analogies to help them, and so predicted a lower score than they actually obtained. Another possibility is that confidence is not closely related to actual performance. The relationship between analogy and confidence is an important issue because confidence is an important aspect of motivation (Keller, 1983). Additional research is needed to explore the relationship and to determine how analogies might be used to increase the confidence of the learners.

The final measured variable included the amount of time they used to both study the concepts and complete the posttest. The results show that subjects in the analogy condition used significantly more time studying than subjects in the no-analogy condition, but did not require significantly more time to complete the posttest. These results are consistent with the findings of Simons (1982; 1984) in which analogies may be more time-consuming, as well as more effective, than other instructional strategies. It is the efficiency of the instruction rather than its effectiveness that is at issue here. Even when they are equal in length, lessons with analogies require more time than lessons without analogies because the analogies require the learners to process the connection between the target and analog in addition to reading the content. Simons notes that there is a trade-off between the increased time needed to use analogies and their benefits in performance. The results of the present experiment support Simons' conclusion. However, the strength of this support is limited by the fact that the lessons used in the present experiment were unequal in length. For the analogy condition the analogies were simply added to the descriptive paragraphs for each concept, which means that the subjects in the analogy condition had more content to read. Subjects in the analogy condition took more time to study the concepts, but their comprehension was improved. The exact location of the balance point is unclear, however, and may be a purely subjective decision to be made by the individual teacher or learner. Additional research is needed to further investigate the relationship between study time and comprehension in concept learning through analogical instruction.

In conclusion, several lines of reasoning converge to suggest that analogies are potentially powerful instructional tools: (a) their pervasiveness in both everyday and instructional communication; (b) anecdotal evidence of their influence in scientific discoveries throughout history; and (c) empirical evidence of their effectiveness in a variety of learning tasks. However, what has been written about analogies is almost entirely descriptive in nature. There is little prescriptive information and, as a result, few guidelines for using analogies in instructional practice. Newby and Stepich (1987) have taken a step toward filling this gap by suggesting a set of procedural guidelines for both creating and utilizing analogies within instruction. The present investigation was undertaken as an empirical test of one of their prescriptions: that analogies are effective given intangible, as well as tangible concepts. The primary finding confirmed this assumption. Secondarily, the study found that using analogies affects the enjoyment of the learners but not their perceived confidence.

References

Bean, T. W., Singer, H., & Cower, S. (1985). Acquisition of a topic schema in high school biology through an analogical study guide. The National Reading Conference Yearbook, 34, 38-41.

Cavese, J. A. (1976). An analogue for the cell. The American Biology Teacher, 38, 108-109.

Curtis, R. V., & Reigeluth, C. M. (1984). The use of analogies in written text. Instructional Science, 13, 99-117.

Davidson, R. E. (1979). The role of metaphor and analogy in learning. In J. R. Levin & V. L. Allen (Eds.). Cognitive learning in children: Theories and strategies. New York: Academic Press.

Dick, W., & Carey, L. (1985). The systematic design of instruction. Glenview, IL: Scott, Foresman & Co.

Drugge, N. L., & Kass, H. (1978). The effect of selected analogies on understanding of scientific explanations. Abstract of Presented Papers, NARST. Cleveland, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education, The Ohio State University.

Gabel, D. L., & Samuel, K. V. (1986). High school students' ability to solve molarity problems and their analog counterparts. Journal of Research in Science Education, 23, 165-176.

Gabel, D. L., & Sherwood, R. D.. (1984). Analyzing difficulties with mole-concept tasks by using familiar analog tasks. Journal of Research in Science Teaching, 21, 843-851.

Gabel, D. L., & Sherwood, R. D.. (1980). Effect of using analogies on chemistry achievement according to Piagetian level. Science Education, 64, 709-716.

Gentner, D. (1988). analogical inference and analogical access. In A. Prieditis (Ed.), Analogica: Proceedings of the first workshop on analogical reasoning. London: Pittman Publishing Co.

Gentner, D. (1982). Are scientific analogies metaphors? In D. S. Maill (Ed.), Metaphor: Problems and perspectives. Atlantic Highlands, NJ: Humanities Press, Inc.

Gentner, D. (1983). Structure-mapping: A theoretical framework for analogy. Cognitive Science, 7, 155-170.

Gentner, D., & Gentner, D. R. (1983). Flowing waters or teeming crowds: Mental models of electricity. In D. Gentner and A. Stevens (Eds.), Mental models. Hillsdale, NJ: Erlbaum.

Gentner, D., & Toupin, C. (1986). Systematicity and surface similarity in the development of analogy. Cognitive Science, 10, 277-300.

Gick, M. L., & Holyoak, K. J. (1980). Analogical problem solving. Cognitive Psychology, 12, 306-355.

Gick, M. L., & Holyoak, K. J. (1983). Schema induction and analogical transfer. Cognitive Psychology, 15, 1-38.

Glass, A., & Holyoak, K. J. (1986). Cognition (2nd edition). New York: Random House.

Gordon, W. J. J. (1961). Synectics: The development of creative capacity. New York: Harper & Row.

Halpern, D. F., Hansen, C., & Riefer, D. (1990). Analogies as an aid to understanding and memory. Journal of Educational Psychology, 82, 298-305.

Holmes, S. (1979). Henderson's dictionary of biological terms (9th edition). New York: Van Nostrand.

Holyoak, K. J. (1984). Analogical thinking and human intelligence. In R. J. Sternberg (Ed.). Advances in the psychology of human intelligence. Hillsdale, NJ: Lawrence Erlbaum Associates.

Holyoak, K. J. (1985). The pragmatics of analogical transfer. In G. H. Bower (Ed.), The psychology of learning and motivation. New York: Academic Press.

Iona, M. (1982). Teaching electricity. Science and Children, 19(2), 22-23.

Jacob, S. W., & Rancone, C. A. (1985). Structure and function in man. Philadelphia: W. B. Saunders Company.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.). Instructional design theories and models: An overview of their current status. Hillsdale, NJ: Erlbaum.

Keller, J. M., & Kopp, T. W. (1987). An application of the ARCS model of motivational design. In C. M. Reigeluth (Ed.), Instructional theories in action: Lessons illustrating selected theories and models. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kerlinger, F. N. (1973). Foundations of behavioral research (2nd edition). New York: Holt, Rinehart and Winston.

Last, A. M. (1985). Doing the dishes: An analogy for use in teaching reaction kinetics. Journal of Chemical Education, 62, 1015-1016.

Ledger, M. (1977). Analogy: A lesson in composition. Exercise Exchange, 21(2), 8-13.

Luciano, D. S., Vanden, A. J., & Sherman, J. H. (1983). Human anatomy and physiology: Structure and function. New York: McGraw-Hill.

Mayer, R. E. (1979). Can advance organizers influence meaningful learning? Review of Educational Research, 49, 371-383.

Mehrens, W. A., & Lehman, I. J. (1984). Measurement and evaluation in education and psychology (3rd edition). New York: Holt, Rinehart, & Winston.

Newby, T. J. (in press). Classroom motivation: Strategies of first-year teachers. Journal of Educational Psychology.

Newby, T. J., & Stepich, D. A. (1987). Learning abstract concepts: The use of analogies as a mediational strategy. Journal of Instructional Development, 10, 20-26.

Nichter, M., & Nichter, M. (1986). Health education by appropriate analogy: Using the familiar to explain the new. Convergence, 19, 63-72.

Parker, S. P. (1984). McGraw-Hill dictionary of scientific and technical terms (3rd edition). New York: McGraw-Hill.

Reed, H. B., & Dick, R. D. (1968). The learning and generalization of abstract and concrete concepts. Journal of Verbal Learning and Verbal Behavior, 7, 486-490.

Reed, S. K., Dempster, A., & Ettinger, M. (1985). Usefulness of analogous solutions for solving algebra word problems. Journal of Experimental Psychology: Learning, Memory, and Cognition, 11, 106-125.

Reigeluth, C. M., & Stein, F. S. (1983). The elaboration theory of instruction. In C. M. Reigeluth (Ed.). Instructional design theories and models: An overview of their current status. Hillsdale, NJ: Erlbaum.

Royer, J. M., & Cable, G. W. (1976). Illustrations, analogies, and facilitating transfer in prose learning. Journal of Educational Psychology, 68, 205-209.

Rumelhart, D. E., & Norman, D. A. (1981). analogical processes in learning. In J. R. Anderson (Ed.). Cognitive skills and their acquisition. Hillsdale, NJ: Lawrence Erlbaum Associates.

Russell, D. (1980). Political spectrum analogy. Social Education, 44, 519.

Scheintaub, H. (1987). Earth elements by analogy. The Science Teacher, 54(4), 29-30.

Schmidt, R. F., & Thews, G. (1983). Human physiology. Berlin: Springer-Verlag.

Schustack, M., & Anderson, J. R. (1979). Effects of analogy to prior knowledge on memory for new information. Journal of Verbal Learning and Verbal Behavior, 18, 565-583.

Simons, P. R. (1982). Concrete analogies as aids in learning from text. In A. Flammer & W. Kintsch (Eds.), Discourse processing. North Holland Publishing Co.

Simons, P. R. (1984). Instructing with analogies. Journal of Educational Psychology, 76, 513-527.

Stepich, D. A., & Newby, T. J. (1988a). Analogical instruction within the information processing paradigm: Effective means to facilitate learning. Instructional Science, 17, 129-144.

Stepich, D. A., & Newby, T. J. (1988b). Analogizing as an instructional strategy. Performance and Instruction, 27(9), 21-23.

Strand, R. L. (1983). Physiology: A regulatory systems approach (2nd edition). New York: McMillan.

Vanden, A. J., Sherman, J. H., & Luciano, D. S. (1980). Human physiology: The Mechanisms of body function. New York: McGraw-Hill.

Vosniadou, S., & Schommer, M. (1988). Explanatory analogies can help children acquire information from expository text. Journal of Educational Psychology, 80, 524-536.

Title:

Educational Biotechnology and a Search for Moral Opposition to it

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EDUCATIONAL BIOTECHNOLOGY AND A SEARCH FOR MORAL OPPOSITION TO IT*

Randall G. Nichols

INTRODUCTION

I have come to the conclusion (Nichols, 1990, 1991) that several aspects of educational technology, especially educational biotechnology (EBT), are harmful to people and to the environment. Something inside tells me that educational technologies will eventually lead to harms that far out-weigh any purported advantages of the technology. And I conclude that this is morally unacceptable. One main issue, then, is presenting publicly this danger and this morality so that others might consider and resist educational technology that does harm. This paper is just such a presentation. And by "others," I mean that I especially want to encourage learners and teachers to think and act more wisely if they conclude that the prospect of a future with EBT is somehow wrong.

In order to begin to get at a discussion of educational biotechnology and morality, the first sections of the paper describe: what could be immoral about educational technology (including EBT), assumptions guiding my current search for answers, characterizations of EBT and related ideas, and professional literature about the issues raised here.

In large part though, I'll examine the critical theory of Habermas, Rorty's liberal ironist, and Barrett's moral will. Though Habermas is the one of the three to be most closely associated with critical theory, his ideas of communication, language, morality, and rationality lead me almost inevitably not only to some light but to Rorty. Rorty's theory of communication and morality strongly contradict Habermas' notion of "the ideal speech situation," where perfect communication and morality are possible. And when both men, as brilliant as they are, leave me short of being able to develop my own moral principles in conjunction with educators, a turn to the existentialist spirit of Barrett is, in essence, inevitable. His ideas about human faith and will and their associations with morals and technology are particularly illuminating. We will turn to these thinkers before much longer.

WHAT COULD BE IMMORAL ABOUT EDUCATIONAL TECHNOLOGY?

Some readers are asking "How could it be that educational technology might be harmful and immoral?" This idea is nearly incomprehensible to many of us. After all, this prospect of the "negative" aspects of technology goes against the proclamations of Apple Computer Corporation's John Sculley, against many local school boards, and against your Sunday paper's glowing report on "The Latest Gizmo-Tech Revolution for Your Child's Education And A Swell Future." I want to indicate just three basic lines along which educational technology just might be shown to be injurious.

First, technology may impede learning by constricting options for learners and parents. The growing accountability movement in American schooling uses technologies (including standardized testing and bureaucratization) more and more to impose widely prescribed curricula and methods on individual schools or districts (Taylor, 1986). To believe we can make good learners with a wealth of stored knowledge is to say that learners can not be responsible for their own selections of appropriate content and learning methods--and so very few are responsible, at least according to the national tests that show us we are failing.

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*Martha Hendricks helped greatly to improve a late draft of this paper. Thank you, Martha. Any errors now in this text are of my own authorship.

Hardison (1989) even goes so far as to speculate that technology is the new and predominant entity on earth and in the heavens, in line to very quickly put humans in a position where we will communicate less and even drop into a kind of universal stupor which is somehow pleasant to us. Of course Hardison implies that these possibilities are mostly good. They are interesting, natural, and milestones of wonderful progress. I believe I disagree.

Socio-culturally, there is quality research which indicates that oppression of less advantaged people is exacerbated by computers in education. Sutton (1991) shows the ways in which uses in American schools indicate that computer use during the 1980s did not bring education closer to equal educational opportunity. Rather, it maintained and exaggerated existing inequalities in education input, processes of computer learning, and output. Poor, female and minority students had less access to computers at home and, in addition, less access to computers at school....Poor and minority students were more likely to use computers for drill and practice than were middle-class and White students, and females outnumbered males in word processing but were underrepresented in programming. Teachers, while concerned about equity, held attitudes which hindered access: They believed that better behaved students deserved computer time and that the primary benefit of computers for low-achieving students was mastery of basic skills....Thus, children who were minority, poor, female, or low achieving were likely to be further behind after the introduction of computers in schools....These inequalities were found in the U.S.A., Great Britain, Australia, Canada, and New Zealand (pp. 494)

Thirdly, technology and educational technology are ecologically destructive first cousins. I hope I do not need to remind anyone of the incredible destruction associated with technology in general, but in the film *After The Warming* (Sattin, 1989), James Burke predicts many decades of social and ecological upheaval and death, even if we could somehow immediately reverse the damage we are doing presently. Which we most likely can not. Education teaches about the wonderful possibilities of technology and about the desirability of using technology to control all aspects of our lives, from child birth to dying, and so encourages destruction. How many millions of personal computers have been purchased in the last decade alone? Do they use the same amount of electricity as a town of over 300,000 or 1,000,000 people? They use a lot of energy, most of it being fueled by carbon-based materials that pollute. And just where does all the used plastic in computers go when its discarded?

So these effects are bad, but what could make them immoral too, how could we be evil in this state of affairs? I suggest that because we now know the extent of negative possibilities, we are *intentionally* choosing to continue on the path of destruction which is needless and wanton. Intentionality is a critical point on which to make many decisions about morals. It is, for instance, one of the principle bases of legal systems; if you know ahead of time of the consequences of an act and knowingly procede with the act, you are all the more guilty. The path of technology is littered with immorality.

Additionally, and reflecting a view that is central to this paper, those few people in positions to make choices that affect the world's population do not subscribe to the moral principle, in cultural morality at least, that everyone should have a free, informed, reasonable, and uncoerced say in what is and is not moral about technology. Vitually none of us had a *direct*, meaningful say in the exorbitant increase in America's nuclear arsenal? Do you have a direct say in how to clean up the devastation caused by this technology? Or will you just wait passively to see what happens? We do not have very much of a democracy in this sense. To the extent that almost none of us participate meaningfully in widespread discussions about these issues, and powerful people are not looking for ways to increase our power, the few powerful people could be construed as immoral.

I can only speculate that engineering of our minds and bodies will only worsen the kinds of techno-moral dilemmas in which we now find ourselves.

ASSUMPTIONS

Several assumptions guide this search to a more moral technology use. First, I assume that educational biotechnology (EBT) is dangerous and that many people with the desire and the ability to do so will use drugs, neural surgery, psychological training, and genetic manipulation to improve memories, thinking skills, and learning attitudes of their children.

It is also an assumption that critical theory and literature related to it will help to show the way to a moral condition in this matter. The ideas of the three theorists discussed here address morals and over-extended rationalization in a lively and current, if not widespread, fashion that is hard to find anywhere else.

Of course I assume (hope?) that we will not destroy ourselves with war weaponry or ecological suicide before we are faced with the problems to which I allude and before we have a chance to reach some more or less common moral agreement about a widespread human stance in relation to these issues. To make the points herein is to have at least a modicum of hope in the face of a future that is quite likely to be very harsh for us and the earth.

I believe, too, that current educational technologies won't positively revolutionize learning in major ways. History supports this assumption (Saettler, 1990). Further, only rarely do the most widely disseminated calls for educational reform and the reforms themselves seem likely to use the fullest capabilities of technology; saturated use of technology is rarely, if ever, recommended by national commissions and the like.

I assume, also, that in the next several years we still will be failing miserably to educate ourselves. I do not mean necessarily that the failure will be in terms of current conceptions of success, which focus on mental facts, concepts, and generalizations or on the societal needs of schooling for nationalistic economic dominance. I mean that our formal education structures will not help us to avoid a crumbling ecology, a starving world population, losses of political rights, and injuries of selfhood.

Perhaps most importantly, I assume that any danger of EBT is part and parcel to the basic problem of a too rational way of life (See Sarason, 1991 about education and rationalization). This is to say we believe too strongly that our logical-instrumental selves can overcome all the problems with which we think we are faced, from poverty to pimples, even though the evidence is that a dominant rationality is too often as destructive of the human spirit and existence as it is healthy. Not only is this conscious self too mentally and emotionally subjugating, but it is also physically detrimental. As Ellul (1990) concludes in *The Technological Bluff*, the power of technology means a "subordination of the individual to machines [and other technologies] over which there is less and less control" (p. 158).

CHARACTERIZATIONS

The meaning of educational biotechnology (EBT) is not pat, but it has been described as "the study and application of scientific and other organized knowledge, processes, and products to the physical state of humans for the purpose of creating changes in learning" (Nichols, 1991, p. 128). For example, when, in utero, a child's genes are engineered to produce a person with virtually no likelihood of being "hyperactive" in school, this is EBT.

Let me briefly characterize "morality" and distinguish it to some basic degree from "ethics." A basic definition of morality is to call it a condition wherein we make judgments "of goodness and badness of human action....'Moral' pertains to personal behavior...measured by prevailing standards of rectitude. 'Ethical' approaches behavior from a philosophical standpoint; it stresses more objectively defined, but essentially idealistic, standards of right and wrong, such as those applicable to the practices of lawyers, doctors, and businessmen" (American Heritage Dictionary, 1979, p. 852).

Ethics implies the codes or laws that derive from moral principles and that are more or less situation specific. Since, in my judgment, practically no one is considering the issues I raise here, and since no widespread conversation (conversation that closely reflects the activities and essences of the three authors examined here) about EBT and morals is occurring, I would be arrogant and misguided (indeed, immoral and unethical) at this point to attempt anything but leaving the details of an ethical system for future conversations. Besides, I'm cautious about any kind of system, as you may discern shortly. Also, the conversations must start among many people, not just among formal philosophers, educators, and technologists. So I like the idea that morals tend to apply more to the goodness and badness of personal behavior, while, at the same time, the notion of morals aims for a greater public good. Further, if the conversations don't happen of our accord, we unavoidably and more harshly will be faced with these issues. And if the talk doesn't happen at the common level it will not take hold generally.

Consequently, this paper contains less about specific ethical codes than it does about what the conversation on morality might look like, what issues in the conversation could be most meaningful, who ought to participate, what moral principles might emerge, and how educational technologies fit into larger views of technology and morals. In other words, you will not find exact ethics directions for living, but some speculations about getting started with the pressing conversations about the morality of EBT.

Turning to the notion of "rational," it is meant here to be the broadest concept of human logical-instrumental thinking and doing. I am referring to nearly any mode of human existence whereby we use logical elements of our thinking to change something in our world. Systematically applying a formal instructional design and development model to the task of educating people is a rational activity. "Rationalistic" is the extended, most intense form of the rational. Notions such as "empiricism" and "positivism" are meant as very closely related sub-concepts of "logical-instrumental," inasmuch as they are more developed, specific manifestations of rationality.

About critical theory, though I suggest it comes up short in some ways, I find it to be a useful foundation to my search for morals associated with educational biotechnology. Many critical theorists assume that "each historical situation is a distortion of the utopian vision that was the normative basis [a moral basis] for the existing social structures and beliefs" (Ewert, 1991, p. 355). These theorists believe that individuals and societies can be better, and that being better involves exposing the meaninglessness of an over-extended rationality, whether this meaninglessness is found in science, economics, politics, mass media, morals, or education. Rationalization in all areas of life has led to erosions of community, self, language, biosphere, and hope, as Habermas will help to show in a later section of this paper.

Thomas McCarthy (1991) describes aspects of critical theory as:
--Challenging the notion of pure reason; showing its changeability depending on culture, history, and power in which it is embedded.
--Likewise, the theory rejects the "Cartesian picture of an autonomous rational subject" who tries to control the world.
--In critical theory the practical takes precedence over the theoretical, but theory is bound to the practical.
--Knowledge is not disembodied from the rest of existence; still, though, a distanced or objectivating understanding of knowledge is needed.
--Established human sciences, scientifically trained experts, and rationalization all come in for close analysis by critical theorists.
--A major purpose of critical theory is to make problematic what is taken for granted in culture (power relationships, often) so that a degree of social justice can be had. (p. 43)

And the critical theorists of the early Frankfurt School "believed that the appropriate method of critique was immanent critique, which proceeds through forcing existing views to their systematic conclusions, bringing them face to face with their incompleteness and contradictions, and, ultimately, with the social conditions of existence" (Young, 1990, p. 18). This belief is a recurrent theme in critical theory even today.

Without inferring too much, then, we could say critical theory leads to the conclusion that rational-technological aspects of humans lead to human alienation and to ecological peril, as Habermas will help to explain.

BACKGROUND LITERATURE

Many people have spoken about technology in general and its moral/ethical implications. Ellul (1990), for instance, speaks to these issues. He talks of how technology is more and more surrounding us and says "This encirclement or outflanking of people and society rests on profound bases (e.g., a change in rationality) and the suppression of moral judgment, with the creation of a new ideology of science" (p. 19). In relation specifically to learning, Ellul (1990) says that, "Pedagogy (learning how to learn) is a central feature of this technisizing of instruction, which implies a culture of practical intelligence in the place of reflective or critical intelligence" (p. 136).

And many people, Strike and Soltis (1985) for instance, have addressed the issue of morals and ethics in education. *The Moral Dimensions of Teaching* (Goodlad, Soder, & Sirotnik, 1990) is a good example of the ongoing concern for ethics and morals within the professional education community. In *Dimensions*, Soder takes a brief look at the "new technology of schooling" (p. 64), but he implies that new technologies like EBT are not likely to proliferate, and besides, it's not clear to me exactly what his chapter has to do with technology and morals. It's mostly about the professionalization of teachers.

In terms of volume, much has been written on critical theory and education. Gerry D. Ewert (1991) and Robert E. Young (1990) are authors of instances of this genre. Further, there is a sense in which critical theorists generally examine technology very closely, when the topic is rationalization and the science, bureaucracy, social hegemony, and pollution that accompany it. Carr and Kemmis (1986), for example, discuss education, knowledge, and research in education in terms of their technical features and uses and the ways these features can be about ethics and morality. And just recently, Feenberg (1991), in *Critical Theory of Technology*, even speaks a little to the relationships of critical theory, technology, *and education*, suggesting at one point that

> we could construct an ideal type of a socialist economic code in which educational activities, which capitalist society considers to be investment and evaluates in terms of productive efficiency, would be placed in the category of consumption and evaluated as contributions to welfare (p. 152).

However, in the critical theory literature, we find virtually no discussion about the combination of EBT, ethics, and critical theory. The topics are never mentioned in conjunction with one another. There is no discussion of which I am aware about the process relationships of these three issues. One way of putting this process problem is to ask how EBT, morality, and critical theory ought to be discussed and used for some positive actions. And though no critical theorist of whom I am aware looks specifically at the future of EBT, the critical theory of Habermas will help to explain how critical theory informs the EBT problem.

If we ask about investigations of the morality and ethics associated with educational technology, this field is somewhat well-represented. For instance, the Association for Educational Communications and Technology (AECT) has a professional ethics committee and statement, and there have been several presentations over the last few years at its annual conference where ethics, morals, and technology were the topics (e.g., Damarin, 1990; Koetting, 1983; Nichols, 1988; Schwen, 1988; Taylor & Swartz, 1988).

In terms of something like EBT all by itself, just a handful of people (Hanson and Gueulette, 1988; Heinich, Molenda, Russell, 1989; Knirk & Gustafson, 1986, to name some of the few) have published in this area, and in most of these instances only tangentially. Hanson and Gueulette (1988) cite several potentially severe problems with EBT ("psychotechnologies" in their terms), but they add, "What is potentially new about transformational technologies and truly indicative of an authentic paradigm shift is the potential to wed psychotechnologies to an ecological vision which balances, not dominates, nature" (p. 240). They urge us to take responsibility for our psychotechnological creations. They seem hopeful that we can create a balanced vision. I, of course, am not so hopeful.

In terms of EBT together with ethics, however, I can find only a couple of citations in the last few years. Dede (1986) claims that "biological manipulation of humans alters internal and affective capabilities: emotions, neurological development, intellectual capacity, genetics, aging" (p. 43). And though he cautions that "These emerging technologies may impose more complex ethical challenges than the atomic bomb, computer, and television combined" (p. 43), he is generally optimistic (very naively optimistic, I believe) about our capacity to prepare our children to assume responsibility for the morality and ethics of EBT. I have written elsewhere about EBT (Nichols, 1990) and propose that "EBT will cause profound doubt, dilemma, and moral consternation about modern thinking and technology. What does it mean to learn, to have knowledge, and to be human" (p. 138) in learning situations characterized by, say, an educational black market for memory enhancing drugs?

In sum, then, very few people are examining a future with EBT. One way to pursue the notion that EBT will proliferate and be destructive is to turn to philosophers of morals for guidance. Moreover, philosophy is an approach which seeks wisdom and seeks to get at basic beliefs (Randall & Buchler, 1970), and, so, calls on evidence that includes but goes beyond the highly rational, the strictly practical.

HABERMAS AND CRITICAL THEORY

So we turn to the critical theorist, Habermas, who analyzes rationality in relation to morals, and whose theory of communicative action is critical of some media and of extreme rationality. According to Ewert (1991), "The central theme in Habermas' work is the development of a comprehensive theory of rationality sufficient to encompass science, morality, and art" (p. 346) [emphasis mine]. There are at least three issues on which Habermas is very attractive. He speaks to: that in us which is less rationalistic (often called "the other"), the character of meaningful communicative acts, and morality.

On the first issue, he speaks to that in humans which is not purely rational, but which is also tacit, intuitive, and only implicit. He calls the "place" where this happens the "lifeworld" and says that it "is an implicit knowledge that can not be represented in an infinite number of propositions; it is holistically structured knowledge, the basic elements of which intrinsically define one another; and it is a knowledge that does not stand at our disposition, inasmuch as we can not always make it conscious and place it in doubt as we please" (Habermas, 1981/1984, p. 336).

Through certain kinds of language, this lifeworld helps to influence our affairs. In his theory of communicative action, Habermas says that, "Language and culture are constitutive of the lifeworld itself" (Habermas, 1981/1987, p. 125). And "when people are in truthful, right, or authentic communication, they use language and culture in such a way that language and culture, too, are implicit, are only on the horizon, are part of the reservoir from which people select knowledge" (Nichols, 1990, p. 35).

Habermas argues that there are several kinds of knowledge and that the communicative use of knowledge means competence in the "unconstrained, unifying, consensus-bringing force of argumentative speech" (Habermas, 1981/1984, p. 10) in order to transmit cultural knowledge, fulfill norms appropriate to a given social context, and socialize individuals at the level of personality (Habermas, 1981/1987, p. 63). Unlike positivist claims, validity claims in this realm are made not by logical-instrumental uses of knowledge but via "nondeductive relations between pragmatic units (speech acts)" (Habermas, 1981/1984, p. 22).

But Habermas does not seek to eliminate the rational altogether; he wants the lifeworld and rationality to meet via argumentation, and he says, "The rationality inherent in this practice is seen in the fact that communicatively achieved agreement must be based in the end on reasons. And the rationality of those who participate in this communicative practice is determined by whether, if necessary, they could, under suitable circumstances, provide reasons for their expressions" (Habermas, 1981/1984, p. 17). "Suitable" requires that there be no coercion, but shared intersubjectivity.

A major concern for Habermas is that rationalization of the lifeworld changes communication and social structures, sometimes in deleterious ways: we rely more on communicative consensus that is more abstract; pedagogical approaches to child-rearing and formal schooling increase; society becomes more legalistic and bureaucratic, while concrete value-orientations decrease and actions aimed more at success than at mutual understanding increase.

In these circumstances, more and more complex social systems have to be coordinated, and Habermas calls some of the mechanisms which do so "delinguistified media." They are delinguistified because they require less and less direct consensual speech/argumentation. Examples of these media include prestige, power, influence, and money [and sometimes electronic mass media]. They threaten us when they either condense or replace mutual understanding in language:

> Media such as money and power attach to empirical ties; they encode a purposive-rational attitude toward calculable amounts of value and make it possible to exert generalized, strategic influence on decisions of other participants while bypassing processes of consensus-oriented communication. Inasmuch as they do not merely simplify linguistic communication, but replace it with a symbolic generalization of rewards and punishments, the lifeworld contexts in which processes of reaching understanding are always embedded are devalued in favor of media-steered interactions; the lifeworld is no longer needed for the coordination

of action (Habermas, 1981/1987, p. 183).

Further, these media become more and more complex so fewer people understand or take responsibility for them, and "In this way the destruction of urban environments as a result of uncontrolled capitalist growth, or the overbureaucratization of the educational system, can be explained as a 'misuse' of media" (Habermas, 1981/1987, p. 293). Note, however, his claim that the base difficulty with this kind of history is attributable ultimately to "an elitist splitting off of expert cultures from contexts of action in daily life" (p. 330); it is the increasingly rationalistic ways in which a few of us think and act that cause us danger.

Habermas (1984) makes this same argument with reference to education having been shifted to schools and away from parents and community. He notes the ways we try to protect children in these removed circumstances by litigation and rules, but he concludes that, "The protection of pupils' and parents' rights against [potentially harmful aspects of] educational measures...is gained at the cost of a judicialization and bureaucratization that penetrate deep into the teaching and learning process" (p. 371). Bringing schooling under the domain of law abstractly groups people in educational competition and achievement processes. So school law becomes the norm, without much consideration of students' and educators' concerns, needs, interests, or life relationships. To the extent this description of rationalization holds, it "has to endanger the pedagogical freedom and initiative of the teacher. The compulsion toward litigation-proof certainty of grades and the over-regulation of the curriculum lead to such phenomena as depersonalization, inhibition of innovation, breakdown of responsibility, immobility, and so forth" (p. 371).

Habermas (1990) takes his theories about communicative action and the degradation of lifeworlds into his most explicit treatment of morality, *Moral Consciousness and Communicative Action*. In this book, he gives his most complete discussions about what he means about the nature of morals. He does not speak directly to the problem I raise here (that EBT will proliferate, be dangerous, and is often immoral), but he does offer a description of moral principles and processes associated with it. And here, too, he argues that the only good way to universal moral principles is via argumentative communication as sketched above.

Two principles, or "rules," guide this discourse on morals. The first is what he calls a universal principle, and it reads, "All affected can accept the consequences and the side effects its general observance can be anticipated to have for the satisfaction of everyone's interests (and these consequences are preferred to those of known alternative possibilities for regulation)" (p. 65). Habermas tries to show that this is a universal because, for instance, everyone who honestly enters an argument presupposes such "rules" as "no speaker may be prevented, by internal or external coercion, from exercising his rights [of speech]" (p. 89).

His second principle of discourse ethics is derived from conditions of the first and says, "Only those norms can claim to be valid that meet (or could meet) with the approval of all affected by their capacity as participants in a practical discourse" (p. 66). This is a practical discourse in which participants must not only reflect and vote on the norm in question but must partake of a fully intersubjective process "that is reflexive in nature; only it can give participants the knowledge that they have collectively become convinced of something" (p. 67). He calls this type of conversation a transcendental-pragmatic justification, in that the intuitive in us and the rational in us meet in conversation.

Habermas is to be applauded for giving us somewhat of a process and universal guides to achieving consensus. His explanation of the features of morals and the processes by which we might meet consensus is very attractive; it is a way to join the intellectual with the tacit in us--and to do so in conjunction with communities of people. He shows how various communities which fight delinquistification and ecological damage have emerged more or less of their own holistic volition, not by legislation and rationalization. He shows that there is hope that a moral condition among people, one which is resistent to rampant technology, can gain a foothold. He searches for ways too rationalized lives can get back to a more balanced, moral condition.

HOW HABERMAS FAILS ME

However, I can not get enough help from him on my immediate need to resist technology now. Habermas is clear that he believes that the road he is suggesting--the transcendental-pragmatic justification of a rule of argumentation--is selective, and that the rule "is not compatible with all substantive legal and moral principles" (p. 94). He says, further, that the rule "is a rule of argumentation only" (p. 94). In other words, applying these principles to specific situations is, at best, difficult and, at worst, nearly impossible since even agreeing to hold conversations such as he suggests is often nearly impossible. When people (men mostly, I suspect) come together to discuss meaningful, pragmatic matters, the participants often are not satisfied with others' arguments. Think about nations trying to find ways to alleviate natural resource destruction. At least to this point in history, participants' conversations are often verbal fist fights, not consensual conversations. And think of most higher education academic units. It is in these units we might expect the most community of conversation; however it is in many of these units where some of the least constructive conversation occurs, at least in several of the education departments and colleges of which I am aware!

And as he says, there is no specific content attached to these rules, only a way to proceed (p. 94). And though having a procedure is helpful, we also need a content to which to attach these principles. For me, then, Habermas is the too extreme rationalist who hasn't, for the moment anyway, come up with anything more than too general principles whose applicability is apparently next to useless in practice!

RORTY'S LIBERAL IRONIST

Rorty (1989) would, in general at least, agree with my last characterization. He criticizes Habermas for thinking that, through communicative reason, a democratic society will embody rationalism, democracy, universalism (p. 67). Rorty thinks that we should be willing to call "true" anything which comes out of free conversation, let alone communicative reason. He wants to drop "the image of a preestablished harmony between the human subject and the object of knowledge" (p. 67) that are advanced by Habermas' rational speech situations.

Whereas Habermas sees a conversation which converges in rationality and universalism, Rorty wants a more contingent, historical and varied existence. He wants

> to stop asking for universal validity. I want to see freely arrived at agreement as agreement on how to accomplish common purposes (e.g., prediction and control of behavior of atoms or people, equalizing life-chances, decreasing cruelty), but I want to see these common purposes against the background of an increasing sense of radical diversity of private purposes, of the radically poetic character of individual lives, and of the merely poetic foundations of the 'we-consciousness' which lies behind our social institutions (p. 67).

At the base of his argument is the notion of a "liberal ironist." And of this notion, Rorty says,

> liberals are the people who think that cruelty is the worst thing we do. I use 'ironist' to name the sort of person who faces up to the contingency of his or her own most central beliefs and desires--someone sufficiently historicist and nominalist to have abandoned the idea that those central beliefs and desires refer back to something beyond the reach of time and chance (p. xv).

Rorty has certain, sometimes contrary, points of view about moral progress. He makes the point,

> The view I am offering says that there is such a thing as moral progress, and that this progress is indeed in the direction of greater human solidarity. But that solidarity is not thought of as recognition of a core self, the human essence, in all human beings. Rather, it is thought of as the ability to see more and more traditional differences (of tribe, religion, race, customs, and the like) as unimportant when compared with similarities with respect to pain and humiliation--the ability to think of people wildly different from ourselves as included in the range of 'us.' That is why I said...that detailed descriptions of particular varieties of pain and humiliation (in, e.g., novels or ethnographies), rather than philosophical or religious treatises, were the modern intellectual's principal contributions to progress (p. 192).

One thing that's nice about Rorty's view is that our apparently endless search for a universal, principled moral existence does not lead necessarily to an empty or confused condition. Though no a priori law exists to tell us how to live--or how to avoid technological calamity--we can take comfort in our similar searches to avoid personal pain and humiliation. To this mundane but solid extent can we make some moral progress regarding technology.

THE TROUBLE WITH RORTY'S VIEW

But there are several ways in which Rorty's position, too, isn't very helpful in my search for a way we might agree that EBT is always dangerous--as well as anything else it might be. For one, his conversations simply don't address technology itself enough. Also, he treads dangerous ground when and if he thinks that being able to predict and control people will lead to equality and decreased cruelty. In one way, I'm making the argument that technology is control and predictability, and this condition is what is most dangerous. I agree with Ellul (1990) that with control always comes some degradation or another of humans. Rorty does not fully address this degradation very well.

And also, there is a good argument that his positions lead to unfettered, unhelpful relativism. One could extend (and many have!) his reasoning to make the point that whatever anyone decides at any one moment is acceptable. I don't want us giving fetal brain tissue from deceased babies to pre-schoolers who are otherwise perfectly ready for learning, even if an entire community, city, or state have agreed to do so. I want to know the extend of the negotiations, of the moral considerations, of the interests represented by actors in the negotiations. Mostly, we need guiding over-riding moral principles because not everything nations and states agree on is moral.

But what most bothers me about his philosophy is that his stances are all stated in positive, propositional language, and so they seem to contradict themselves by being suspiciously sure of what they say. How is it sensible that he can say, on one hand, that life is contingent, then say, on the other hand, something so sure as,

> our responsibilities to others constitute only the public side of our lives, a side which competes with our private affections and our private attempts at self-creation, and which has no automatic priority over such private motives. Whether it has priority in any given case is a matter for deliberation, a process which will usually not be aided by appeal to 'classical first principles.' Moral obligation is...to be thrown in with a lot of other considerations, rather than automatically trump them (p. 194).

How can he be so sure of this statement when he has just said that there is contingency in everything? If his statement about no automatic trumping is so, how can he begin to claim so surely that pain and humiliation are *the* central human concerns?

And lastly, he doesn't give me guidance by showing me particular enough morality or ethics. His advice is to create a morality that fits the times and could be useful, but I'm looking for something more concrete. Do I have to wait, probably until it's too late, for all of us to get together and reach agreement about dangerous technology? That agreement may never happen, and I want to know soon what widely accepted moral principles to go by in this matter.

BARRETT'S WILL TO FAITH

To this point, then, my hunt for moral guidance in an age of biotechnological schooling has been unsure. Habermas can not sustain his arguments for a moral principle on which we can all agree, and Rorty leaves open the door for relativism that might have us embracing technology too easily, and he gives me little hope for explicit principles that help us to avoid self-destruction via EBT.

William Barrett (1987), on the other hand, focuses not just on questions of human rationality, argumentation, or shared pain and humiliation as a common human basis. He appears to look farther and higher. He looks at moral questions by raising our moral will to the highest of conditions with which to be graced as a human being. He believes that to achieve freedom we must "try to restore the moral will to a central and primary role in the human personality" (p. 254).

One of his main themes is that faith leading to freedom and action is stymied by technique. Because we live predominantly in a technical era, where instead of the moral will we are the "will to self-assertion and dominance; the will to power" (p. 253), we live in dangerous times, and "The question for our generation...is whether or not mankind will decide for liberty or sink under some modern form of tyranny. And this question is in the end a moral matter" (p. 246).

He suggests that we can sometimes succeed in our moral responsibilities by using traditional and "ritual practices or codes of behavior that might possibility prepare the will for deliverance" (p. 263). He says, "To surrender yourself in the ritual act is a gesture of your humility and ignorance, helplessness and hopefulness, of which the epistemological act is quite incapable" (p. 309). I take Barrett to mean that prayer, thanksgiving, and acknowledgement of the human will to live are moral rituals.

Barrett has given us some clues about being in a moral state. He suggests actions for getting to this moral condition: we must have faith, we must attend to the spiritual in us, we should not believe too much in technique and let it rule our existences.

THE TROUBLE WITH BARRETT

And I believe Barrett is correct, as far as he goes. There is at least one way in which I must point out what might be a contradiction. Yes, people clearly *are* filled with a will to power (see studies by Michel Foucault on this issue, of course.) We are filled with the self will to dominate. And Barrett (1978) seems to argue that to be in a more moral and a less controlling condition requires that we must will to be will-less? But isn't this a contradictory action? We should *will* to be will-less? He attemps to answer this, at least in terms of a blance between the known in life and the mystery of life, with the response "At every moment of every day of our lives, we are involved in a continuous and living transaction with the unknown. This being the case, what then shall be my strategy? It is this: to multiply my points of contact with this unknown wherever I can let it work to my advantage; to deny myself none of its privileges that its unbounded resources might offer" (p. 307). I think Barrett says we are both conditions and that faith is that which we already possess by virtue of existence; humans can not be in one state exclusive of the other, in a faithful condition but not in a will-to-power condition. Rather, he would say that we tend toward one condition or another and that we should now tend toward the moral and the possibilities for greater faithfulness.

Instead, perhaps we gain morality by *giving up* power to the greatest extent possible, by letting go of actions and thoughts that attach to willfulness. It is an interesting question: do we gain a good life by giving up to the extent possible our tendencies to dominate existence, or do we achieve the good life through a more assiduous, conscious, purposeful willing of faith?

Likewise, I want suggest an ironic contradiction that begs for attention (though this is not the most appropriate forum for the bulk of that attention) in this discussion and asks in what sense can or should we resist or deny our rationality, our techno-centrism if you will? It is not an aside to ask if *anything* should be done. That is, should we assume the power to change things by thinking and resisting? I do not think so, but perhaps we should just let nature, including our human nature, take its course? Shouldn't we stop trying to control existence when it's our controlling aspect that may be the culprit to begin with? We might end in some kind of oblivion if we just let it go on, but we might end up in a worse kind of oblivion (psychic, ecological, or cultural oblivion) I've speculated about elsewhere (1990) if we pursue answers these problems. This is quite an uneasy dilemma we live in! Damned if we do will our existence, less damned if we don't?

SOME IMPLICATIONS

Few people are examining the question of EBT. So I predict that, as is historically typical of us, we will wait until the worst aspects of educational and general technology are upon us before we act to fully consider their implications. In the relatively short-term future, the number of EBTs will increase surprisingly quickly; we will be faced with incredibly wider-ranging student and social differences, so cultural upheavals will occur (Nichols, 1990). Habermas notes that any moral can be valid only when it has the approval of all affected, and elitist cultures splitting off from mainstream cultures cause losses of the lifeworld and the physical world. I expect that the uses of EBTs will not be determined in consensual fashion, but will be driven by a certain elite few. And some groups of people, the disadvantaged, will not stand by calmly as other groups use technology to maintain or widen any socio-economic and ecological advantages. I claim that technology and education will produce socio-cultural wars.

These are not especially unusual predictions. A more unsettling revelation comes to me from somewhat beyond the text I have overtly presented so far, and that revelation makes it difficult for me to be faithful in this search for moral wisdom. Having looked at each author's thoughts, I conclude that Habermas, Rorty, and Barrett amount to next to nothing in the current mainstream conversations about today's education, technology, and goodness. Most people in colleges of education, to say nothing of people in our other schools, have not heard of these three essayists. That their names are unfamiliar is excusable. But their ideas go largely unnoticed in the world of day-to-day American schooling and its reform. We in education are dealing mostly with issues of the obviously practical and the here-and-now: how can technology improve student performance, how can we produce more technically competent teachers, how can American schools keep up with the Japanese?

So I repeat, how do we raise the philosophical-moral issues to more conscious and pragmatic levels, especially for teachers and learners? Doing so is extremely difficult when, as Strike (1991) sees it, the problem is "the inability of the public to consume sophisticated [philosophical] discussions about public life" (p. 414). As Rorty (1989) puts it, how do we foster an "increasing sense of radical diversity and of private purposes" that will foster greater human solidarity?

One way to make the issues more publicly prominent is to increasingly raise these issues in public forums. We *should* continue to raise doubt about human technical aspects. Habermas' communicative reason, Rorty's liberal ironist, and Barrett's will to faith are ideas that can become popular, perhaps even before too many self-inflicted disasters enlighten us. I think the main question about the ideas is when we will address them--while we have a little time or when we are at an intellectual, physical, spiritual, and emotional rock bottom. I suspect we'll wait for the bottom.

Still though, we *should* move toward a greater degree of fundamental thinking now, and I believe that the best practical faculty we have for encouraging the questions is personal conversation. This is the case because conversation is a main way in which the ideas mentioned herein have the most likelihood of being meaningful to us (also see Ong, 1982, on this issue). And in its favor, the critical theory of Habermas as described in his theory of communicative action (1981/1984; 1981/1987) is of some help to us. (It is an important aside to note that personal conversation will have the benefit of encouraging democracy.)

In order to stop the bureaucratization and technologizing of education, we must take this conversation, this democracy, more directly to teachers and learners than some of us in higher education have done heretofore. They do not need more highly abstract, academic papers. Learners and teachers do not need more coercing from technology companies or from principals and parents blinded by the light of technology. They need radical, on-site support from those of us who are fortunate enough to have the professorships and other such positions that allow us time, some good ideas, and the desire to mobilize teacher and learner resistance, where it is necessary. We should join and participate in the NEA, for instance.

In my own participation, I must look closely at my motives (Nichols, 1987); I must constantly ask if my actions, my will, are the will to have destructive and dominating power for myself and others or the will to let in the faith and conversation in life that exists already. I look for change based on my attending to my intuition that much technology is needlessly dangerous, and by going to teachers and students with these ideas; I will not extol the purported virtue of technology disengaged from its moral/existential base. This is especially the case in classes I teach, but it is the case everywhere I am.

And, regardless of our inability to pin down many specific universal moral principles in terms of Habermas, Rorty, or Barrett, I believe there are universals--at least ones that go on for most people for long, long times. We should, for instance, follow the universal that we must press the search for moral conditions, moral progress, and see to it that this progress is indeed in the direction of greater human solidarity. Searching in and of itself is a moral act if it is guided by a desire to improve our circumstances in the whole of existence.

Another meaningful morality is the inclination to live rather than die. This inclination appears to me to be inherent in mostly every animal and person, and so it is essentially a universal. Becker (1973) has written wonderfully on this issue and shows that most often people try to live. Barrett (1987) goes so far as to say, "Death remains the supreme adventure to test the moral will" (p.

260). Life, then, is unavoidably a question of morality, whether we acknowledge so or perpetuate and exacerbate the dangers of technology by staying unaware of the questions.

CONCLUSION

To end then, most of us live the moral life simply by clinging to life. And ironically, technology is a manifestation of this clinging, a manifestation which is outgrowing its usefulness/faithfulness. As Barrett suggests, maybe we need to tend to the more existential or spiritual aspect of our lives.

And the morality of living is an idea from which many other morals can be said to derive. "Treat your neighbor as yourself," for example. But ironically again, there seems to be a contrasting, ironic human universal that says we should use (and extend?) our conscious, rational capacities. If we can think of something technological, we will make it. No matter how destructive it may be. (And, of course, some technologies could be positive.)

About this irony of life versus over-extended technology, there is another moral idea that might be helpful: We must at least achieve a *balanced use of technology* (as is the topic of *Koyaanisqatsi*, Reggio, 1983), so that we don't have schools, people, life out of moral and physical balance, so that we might avoid too many unnecessary and intentional deaths.

Perhaps ultimately, as P.D. James (1991) suggests, "Conscience is the voice of God." However you describe your god.

REFERENCES

Barrett, W. (1978).*The illusion of technique*. Garden City, NY; Anchor Press.

Barrett, W. (1987). *Death of the soul*. Garden City, NY: Anchor Books.

Becker, Ernest. (1973). *The denial of death*. New York: The Free Press.

Carr, W. & Kemmis, S. (1986). Becoming critical-Education, knowledge, and action research. London & Philadelphia: The Falmer Press.

Damarin, S. K. (1990). Unthinking educational technology. In The *1989 proceedings of selected research paper presentations of the research and theory division*. Washington, D.C.: The Association for Educational Communications and Technology.

Dede, C. (Speaker, Annual Meeting of the Association for Educational Communications and Technology). (1990). *The coming transformation of educational technology*. (Cassette Recording No. C115-368). Washington, DC: Association for Educational Communications and Technology.

Ellul, J. (1964). *The technological society*. New York: Vintage Books.

Ellul, J. (1990). *The technological bluff*. Grand Rapids, MI: Eerdmans Pub. Co.

Ewert, G. D. (1991). Habermas and education: A comprehensive overview of the influence of Habermas in educational literature. *Review of educational research, 61*, 345-378.

Fosnot, C. T. (1988). The dance of education. In *AECT research and theory division proceedings--1988*. Washington, DC: Association for Educational Communications and Technology.

Goodlad, J.; Soder, R.; Sirotnik, K. (Eds.). (1990). *The moral dimensions of teaching*. San Francisco: Jossey-Bass Publications.

Gustafson, K. (1988). Implications of instructional technologies for the future of education. *Journal of instructional development, 11*,(3) 10-15.

Habermas, J. (1990). *Moral consciousness and communicative action* (C. Lenhart & S. Nicholsen, Trans.). Cambridge, MA: The MIT Press. (Original work published 1983)

Habermas, J. (1984). *The theory of communicative action: Vol. 1, reason and the rationalization of society.* (Thomas McCarthy, Trans.). Boston, MA: Beacon Press. (Original work published 1981)

Habermas, J. (1987). *The theory of communicative action: Vol. 2, lifeworld and system: a critique of functionalist reason.* (Thomas McCarthy, Trans.). Boston, MA: Beacon Press. (Original work published 1981)

Hanson, C. & Gueulette, D. (1988). Psychotechnology as instructional technology: Systems for a deliberate change in consciousness. Educational Communications and Technology Journal, 36, (4) 231-242.

Hardison, Jr., O.B. (1989). Disappearing through the skylight. NY: Penguin.

Heinich, R., Molenda, M., & Russell, J. (1989). Instructional media and the new *technologies of instruction.* New York: Macmillan.

Hlynka, D. & Belland, J. (1991). (Eds.), *Paradigms regained: Uses of Illuminative, semiotic and post structural criticism as a mode of inquiry in educational technology.* Englewood Cliffs, NJ: Educational Technology Publications.

James, P.D. (1991). [Interview at end of *Devices and desires*, final episode]. *Mystery.* Public Broadcasting System.

Knirk, F.G. & Gustafson, K.L. (1986). Instructional technology--A systematic approach to education. New York: Holt, Rinehart and Winston.

Koetting, J. Randall. (1983). Philosophical foundations of instructional technology. *1983 proceedings of selected research paper presentations of the research and theory division.* Washington, DC: Association for Educational Communications and Technology.

Lang, R.M. (Ed.). (1990). [Special issue]. *Journal of thought., 25* (1&2). DeKalb, IL: Northern Illinois University.

McCarthy, T. (1991). *Ideals and illusions: On reconstruction and deconstruction* in contemporary critical theory. Cambridge, MA: MIT Press.

Nichols, R. G. (1987). Toward a conscience: Negative aspects of educational technology. *Journal of Visual Literacy,* 1987, 7(1), 60-71.

Nichols, R. G. (1988). Educational technology: A moral issue. In AECT *Research and Theory Division Proceedings-1988.* Washington, DC: Association for Educational Communications and Technology.

Nichols, R. G. (1990). Reconciling educational technology with the lifeworld: A study of Habermas' theory of communicative action. *Ohio Media Spectrum, 42*,(3) 32-39. Nichols, R. G. (1990). Speculations on a catastrophic future, education, and technology. *Journal of Thought, 25* (1&2), 126-142.

Nichols, R. G. (1991). Toward a conscience: Negative aspects of educational technology. In D. Hlynka and J. Belland (Eds.), *Paradigms regained: Uses of illuminative, semiotic and post structural criticism as a mode of inquiry in educational technology* (pp. 121-137). Englewood Cliffs, NJ: Educational Technology Publications.

Ong, W.J. (1982). *From orality to literacy: The technologizing of the word.* New York: Methuen.

Randall, J.H. & Buchler, J. (1971). *Philosophy: An introduction..* New York: Barnes & Noble Books.

Reggio, G. (Producer), & Reggio, G. (Director). (1983). *Koyaanisqatsi* [Film]. Pacific Arts Video Records; MGM.

Rorty, R. (1989). *Contingency, Irony, and Solidarity.* Cambridge: Cambridge University Press. Settler, P. (1990). *The evolution of American educational technology.* Englewood, CO: Libraries Unlimited.

Sarason, S. (1990). *The predictable failure of educational reform.* San Francisco: Jossey-Bass.

Sattin, R. (Producer), Slee, M. (1989). *After the warming* [Film]. Maryland Public Television & Film Australia.

Schwen, T.M. (1988). Professional ethics: An analysis of some arguments for development of virtuous behavior. In *Research and Theory Division Proceedings--1988.* Washington, D.C.: Association for Educational Communications and Technology.

Strike, K. & Soltis, J. (1985). *The Ethics of teaching.* New York: Teachers College Press.

Strike, K., (1991). The moral role of schooling in a liberal democratic society. In G. Grant (Ed.), Review of Research. Washington, D.C.: American Educational Research Association.

Sutton, R. E. (1991). Equity and computers in the schools: A decade of research. *Review of Educational Research,* 61(4), 475-503.

Taylor, W.D. & Swartz, J. (1988).Instructional technology and proliferating world views. In*Research and theory division proceedings-1988. Washington, D.C.: Association for Educational Communications and Technology.*

Taylor, W. D. & Johnsen, J. B. (1986). Resisting technological momentum. In J.A. Culbertson and L.L. Cunningham (Eds.),*Technology and education (85th yearbook of the national society for the study of education).* Chicago: University of Chicago Press.

Young, R. E. (1990). *A critical theory of education.* New York: Teachers College Press.

Title:

Evaluation of Videodisc Modules: A Mixed Methods Approach

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Evaluation of Videodisc Modules: A Mixed Method Approach

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Abstract

The purpose of this study was to evaluate the design and implementation of 10 neuropathology interactive videodisc instructional (IVI) modules used by Michigan State University medical students in the College of Osteopathic Medicine and the College of Human Medicine. The evaluation strategy incorporated a mixed method approach using qualitative and quantitative data to examine levels of student acceptance for the modules; ways in which IVI modules accommodate different learner styles; and to what extent the modules facilitate the attainment of higher level learning objectives. Students rated the units highly for learning effectiveness; many students reported group interaction as beneficial; and students expressed a desire for more IVI in the curriculum. The paper concludes with recommendations for future use of interactive videodisc technology in the teaching/learning process.

Introduction

The 1984 report issued by the Panel on the General Professional Education of the Physician and College Preparation for Medicine (GPEP) challenged medical educators to make substantive changes in both content and delivery of medical school curricula.[1] Especially relevant to this study is the GPEP recommendation that medical educators implement alternative teaching methods so as to reduce students' reliance on lectures as a primary source for information.[2] Also relevant are report recommendations that medical schools and faculty: (1) adopt teaching methods for students who have the ability to learn independently and provide opportunities for further development of this skill; (2) reduce passive learning and require students to be active, independent learners and problem solvers; and, (3) promote the effective use and application of information science and computer technology.[3] The MSU Colleges of Osteopathic and Human Medicine have instituted a curricular revision process to incorporate the GPEP recommendations.

A partial answer to successful implementation of the GPEP recommendations has reportedly been found in the instructional application of computer based interactive videodisc technology.[4][5] Authors Xakellis and Gjerde state that: "Computer aided instruction is currently viewed by many as one approach to meeting this educational need" for increasing problem solving and self study skills.[6] Among medical subjects that have used interactive videodisc instruction (IVI) in instructional programs are anatomy, radiology, pathology, and psychiatry.[4],[7],[8] In this study, interactive videodisc units were an integral part of preclinical neuropathology instruction.

Interactive videodisc instruction, as defined here, is the use of a computer based instructional program that accesses visual images stored on a videodisc in an order controlled by the learner. A programmed computer accesses different sections of the videodisc or instructional text, depending on the viewer's response to various alternatives. This instructional delivery strategy provides individualized, self paced content information accompanied by instantaneous feedback. Since the medium is inherently visual, it is especially well suited to any discipline requiring motion, animation, pictures, or other visual stimuli to facilitate the learning process. Michigan State University personnel developed the IVI neuropathology modules in HyperCard for Macintosh computers using images from the "Slice of Life" videodisc (a generic videodisc distributed by the University of Utah).[9] These modules were used by undergraduate medical students in the Michigan State University College of Osteopathic Medicine (MSU/COM) and College of Human Medicine (MSU/CHM).

This study incorporates elements of field based, ethnographic and other qualitative evaluation strategies with traditional quantitative methods. These multiple methods were implemented in an attempt to generate a body of relevant learner response criteria that might be applicable to other technology based learning settings. The evaluation strategy was a conscious attempt to, as Hagler suggests, "move to studies of instruction and learners, not media."[10] The evaluation process was patterned on what Patton describes as the "qualitative-naturalistic-formative approach...especially appropriate for programs that are developing, innovative, or changing, where the focus is on program improvement, facilitating more effective implementation, and exploring a variety of effects on participants."[11] This research process seeks to address the limitations and inadequacies inherent in research and evaluation studies which use experimental and quasi experimental designs to compare interactive videodisc technology with other instructional delivery systems or "traditional instruction," often with inconclusive results.[12],[13]

Because a qualitative inquiry approach was included, some data gathering strategies were generated by the evaluation process itself. For example, early results from online quantitative evaluation data allowed the implementation team to synthesize a series of questions for focus group interviews. Both focus group interviews and online data lead to three major questions for the implementation team: (1) What are the levels of student acceptance for the implemented IVI materials?; (2) Did the IVI modules accommodate different learner styles?; and (3) To what extent do IVI modules facilitate the attainment of higher level course objectives? These questions will be addressed in the Discussion section of this paper.

Method

IVI Implementation - Interactive videodisc instructional modules were developed on 10 neuropathology topics: neurocytology/ cytopathology, degenerative disorders, increased intracranial pressure, inflammatory diseases, slow virus diseases, neoplasms, traumatic disorders, cerebrovascular disorders, developmental disorders, and toxic/ metabolic/nutritional disorders. Each IVI module consists of: a five question pretest with an indication of correct and incorrect responses; an instructional lesson with related review questions covering the content required for examinations; a posttest with content feedback for each answer; case studies designed to reinforce concepts presented elsewhere and support problem solving strategies related to neuroanatomy, neuropathology and neurology; and a glossary accessed from the lesson or case study, or used separately. A randomly accessible table of contents (index) is available in the lesson to permit student control over lesson sequencing. A "comments" field is provided for students to leave notes to the instructor or instructional designers. An electronic mail system is being tested to expedite student-instructor dialogue regarding questions as they arise.

There are three curricular formats in the two medical schools at Michigan State University and the neuropathology IVI modules were implemented according to the nature of each curriculum. Described below are the three types of curricula and modes of implementation.

1. The College of Osteopathic Medicine teaches neuropathology within a systems curriculum. The IVI neuropathology modules were utilized two ways in different years.

- During Fall 1989, 118 third year students enrolled in the neuroscience system course were awarded extra credit points (one per module) for viewing and evaluating the eight IVI modules then available. The modules included: neurocytology/cytopathology; degenerative disorders; increased intracranial pressure; inflammatory diseases; slow virus diseases; neoplasms; traumatic disorders; and cerebrovascular disorders. During Fall 1990, a more extensive evaluation and tracking system was available. The 112 third year students enrolled in the neuroscience system course were required to view three IVI modules: neoplasms; cerebrovascular disorders; and a student selected module. Computer use was monitored for required modules. The remaining IVI modules were recommended, but use was elective.

2. The College of Human Medicine uses a two track curriculum:

- Students in Track I are taught in discipline based courses. During Spring 1990, 68 second year students enrolled in the neuropathology course were required to view four IVI modules (neoplasms; cerebrovascular disorders; trauma; inflammatory disorders) with computer use monitored. The remaining IVI modules were recommended, but use was elective. Lectures and written class materials were also available, as in previous years.

- Students in Track II are taught in a problem based, independent study curriculum where "focal problems" organize basic science content. During Spring 1990, 42 first year students were enrolled in the "Impaired Consciousness" focal problem where the primary content is neuroscience. The following IVI modules were on the list of required course materials: neoplasms; cerebrovascular disorders; inflammatory disorders; trauma; and increased intracranial pressure. However, computer use was elective.

The data, therefore, span the period from Fall 1989 to Fall 1990 and incorporate information about 340 MSU medical students enrolled in three curricular formats.

Two on-line questionnaires - a module-specific evaluation and a student information form - were used to collect initial quantitative data. A computerized student tracking system provided important support data to more fully analyze usage, time spent in the module components, and levels of acceptance for the IVI course materials.

IVI Module-Specific Evaluation - Questions presented after each module assessed the effectiveness of various instructional attributes of each module component; e.g., lesson, case study, posttest questions, and glossary. An open comments field was available to record student comments about other features of the module not included above.

Student Information Form - A student information form collected data about prior computer experience, effectiveness of group versus individual use, optimal group size, appeal of overall design features, and the preferred role of computer instruction in the medical school curriculum.

Student Tracking System - A computerized student tracking system collected data about the amount of time spent in each individual module component by each student, module-specific pretest and posttest scores for correct first responses, and the group size for the reported session.

Focus Groups - During the term the course was offered to CHM students, focus groups were organized. Both Track I and Track II students were invited; however, due to schedule constraints, Track II students did not participate. There were 5 to 10 Track I students in each of three focus group sessions. To encourage voluntary participation, each meeting was scheduled at noon with lunch provided. The session format included a brief explanation of the background and rationale for developing the IVI modules, orientation to the purpose of the focus group, and a description of the evaluation study prior to discussion of the interview guide questions. The interview guide explored the following areas: hardware, utility of the IVI modules to help students achieve levels of mastery, appropriateness of module content, organizational factors, motivational factors, and self-testing components within the module.

Results

Data from the Module-Specific Evaluation Form - Table 1 presents a summary of the data obtained for selected questions from the on-line evaluation forms for all students. Each of the 340 students had an opportunity to fill out evaluation forms on from five to ten modules, depending on their curricular format. A total of 547 forms were analyzed; however, not all questions were answered. The total number of responses for each question is indicated in the table. Bartlett's Test for Homogeneity of Variance across the three curricular formats indicates no significant differences in response variability among the groups (p=.60). The three groups were: (1) COM 1990 students; (2) CHM Track I students; and (3) CHM Track II students. Therefore, responses were pooled for each question.

Table 1. Results on Module-Specific Evaluation Forms

Statement	n[1]	Mean[2]	% A/SA	% D/SD
LESSON:				
This unit helped me learn the material.	542	3.44	100	0
The content presented was too easy.	535	1.95	8	92
The inclusion of videodisc images was valuable.	538	3.45	98	2
More videodisc images should be presented.	534	3.09	80	20
The review questions did not help and should be deleted.	533	1.55	3	97
The computer diagrams helped to illustrate concepts.	527	3.29	98	2
I would recommend this section to others.	534	3.45	99	1
CASE STUDY:				
The case study challenged me to think about clinical/pathological problem solving.	480	3.35	96	4
The questions/feedback effectively reinforced neuroanatomy and neuropathology.	516	3.38	98	2
There should be more case studies on this topic.	478	2.81	69	31
I would recommend this section to others.	511	3.36	98	2
POSTTEST:				
The explanations in the posttest helped to reinforce the main concepts.	516	3.44	98	2
The questions were too easy.	521	2.07	18	82
GLOSSARY:				
The glossary was NOT a useful feature.	451	2.23	26	74

[1] Number of responses to each question.

[2] Mean of responses where 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree

Results indicate that students rated all aspects of the modules as very valuable in helping master the material, including content, images, diagrams, glossary, and review questions. In addition, many of the open ended comments written by students were extremely positive and emphasized the value and effectiveness of the IVI modules in helping them master course content.

Data from the Student Information Form - Completion of this form was totally optional. Although the sample was relatively small (n=47) and self selected, the researchers believe that the opinions expressed were important for planning and future program development. Results indicate a fairly even distribution in previous computer experience, ranging from no previous experience to experienced users. The majority of students (66%) reporting prior experience had used a Macintosh computer. A majority of students (72%) who used the modules in small group study (two to three students) stated that interaction was beneficial. In response to a question about optimal study group size, 49% stated that two was optimal; and 36% said three was optimal. The remaining students, only 15%, preferred more than three in a study group. Most students (91%) liked the option of leaving a comment and 87% requested an on-line mechanism to obtain timely answers to their questions from the instructor. Responding to the statement, "Computer instruction is best suited for replacing lectures for some material," 67% of the students agreed and 33% disagreed. Students said they would prefer to spend more time using computer based instruction (CBI) than they are currently spending (e.g., 38% are currently spending three hours or more per week; 72% said they would prefer to use CBI three hours or more per week). When asked about additional features, more students requested an expansion of the case study section than any of the other parts.

Data from the Computerized Student Tracking System - Table 2 provides a summary of the tracking data important for the analysis of IVI module usage. Data were recorded for each individual student, whether working individually or in a small group. The different modes of implementation provide the opportunity to analyze student use in different ways so student tracking data were recorded

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separately for each curricular format and mode of implementation. For all curricular formats, students using the modules spent enough time to master the material in both the lesson and case study. There was no substantial difference in the time spent in each section based on whether use was required or not required; the amount of content appeared to be the major factor in determining average time spent.

(Insert Table 2 about here)

- For Track I students (**discipline-based curriculum**), four modules were required. Analysis of the number of students logged on to optional modules indicates that many students (about half of those enrolled) used non-required IVI modules, although the content was also covered in lecture and written course materials.

- For Track II students (**problem-based curriculum**), content in five of the modules was included in the exam, but use of the computer was not required. Student tracking data indicate that a majority of students did use the IVI modules. For modules with the major neuropathology content, Track II students spent more time in the lesson than Track I students. Since Track II students have less opportunity to see examples of visual images of neuropathology lesions presented, the increased time in the lesson may be attributed to the increased time students spent interacting with the visual material.

- For College of Osteopathic Medicine students in the neuroscience system during Fall of 1989, a total of 798 extra credit points were awarded to the 118 students enrolled (85% of the total possible points available for this activity). Eighty-seven students (74%) completed all eight modules available at that time and only nine students did not use any of the modules. Although students did not have to complete the Case Study to receive extra credit points, about half of the students used this section.

- For College of Osteopathic Medicine students in the neuroscience system during Fall 1990, students were required to complete three IVI modules: cerebrovascular disorders; neoplasms; and one more of their choice. About one third of the students used the non-required modules.

Data from the Student Focus Group Sessions - The following six points summarize the three focus group sessions:

1. Hardware: Most students stated that the equipment was reasonably easy to use. Levels of computer literacy varied greatly; however, lack of familiarity with hardware did not seem to be an inhibiting factor in students' perceived comfort with the computers.

2. Utility of the IVI modules to help students achieve levels of mastery: A majority of students remarked that the modules were best suited for acquiring basic concepts and principles, and practicing with case studies. Several students recommended that the course be structured to make the modules required prior to attending lecture. Assuming that students used the modules to understand the basics, lectures could then be used for higher order learning, such as integration, clinical correlations, and problem solving. In this way, lecture time could be spent going beyond the module acquired basics to discussion of application of the basic content.

3. Content and design of the computer based modules: Helpful features specifically mentioned included the glossary and the visual ability to compare normal and abnormal images. Recommendations for improvement included providing text references with the feedback for the sample test questions and tying the neuropathology IVI module content to previously learned neuroanatomy course material.

4. Organizational factors: Several students commented on the excellent organization of the IVI teaching modules and how well they fit into the overall course. For example, students said they liked the reference points provided throughout a given module, signaling how far along they were in the lesson, e.g., card 15 of 75. Students expressed appreciation for the variety and diversity in case studies and the parallel between the IVI modules and the course syllabus. Students preferred units completed in one sitting and judged certain modules to be too long.

5. Motivational factors: Several students mentioned that requiring completion of certain modules was an effective strategy, since it introduced students to the computer based modules. The majority of focus group participants indicated that they went on to complete more than the required modules because they judged them to be useful and fun. Without the requirement, students speculated that many would not have tried the IVI modules at all. Some students commented that they were motivated by the novelty of using computer based instruction as an alternative to traditional learning methods.

6. Self examination: Students commented frequently and spontaneously on the evaluation aspects of the modules and on the pretests and posttests in particular. They liked the idea of the self-tests but had several suggestions for improvement. Among the most frequent suggestions were: increase the number and frequency of test questions throughout the lesson and make the questions more challenging (e.g., more synthesis or analysis level questions).

Table 2

Student Tracking Data

		CHM Track I				CHM Track II				COM 1989				COM 1990			
	Module	n		minutes /student		n		minutes /student		n		minutes /student		n		minutes /student	
		L	C	L	C	L	C	L	C	L	C	L	C	L	C	L	C
# *	Cerebrovascular	32	29	53	22	21	14	65	25	76	40	55	15	69	50	60	30
# *	Neoplasms	47	40	65	21	20	11	71	20	68	35	51	23	67	51	80	20
*	Trauma	55	44	45	13	20	16	56	25	85	45	39	11	34	11	44	11
*	Inflammatory	22	21	51	22	16	12	63	16	85	33	42	8	26	16	45	16
	Increased ICP	16	12	34	13	19	13	56	13	84	41	26	19	11	8	51	12
	Cytopathology	19	NA	33	NA	NA	NA	NA	NA	56	NA	25	NA	21	NA	29	NA
	Degenerative	34	31	56	7	NA	NA	NA	NA	95	54	33	6	25	13	44	11
	Developmental	38	35	63	9	NA	NA	NA	NA	NA	NA	NA	NA	22	7	45	4
	Slow Virus	21	20	20	6	NA	NA	NA	NA	92	51	25	5	39	20	17	7
	Toxic-Met-Nutr	30	22	49	14	NA	NA	NA	NA	NA	NA	NA	NA	25	7	38	11

Required for COM
* Required for Track I

L = Lesson C = Case Study NA = Not Applicable

Discussion

Data emerging from the various evaluation methodologies support a high level of student acceptance for the implemented IVI materials. Student tracking data suggest that students took the time in each module to cover the material and explore various module alternatives rather than doing the minimum needed to receive credit. Module-specific evaluation forms reflect this positive response with 100% of students stating that they would recommend the modules to other students and that the IVI lesson helped them learn the material. Focus group responses and student tracking data reinforced high levels of acceptance, with students reporting they they completed optional modules and that they liked the IVI approach. The high level of student acceptance was related in part to a high correlation of IVI module content with course syllabus and lecture content.

One objective in module development was to accommodate different learner styles. Students who used the IVI modules reported different patterns of use of the learner control options: pacing control, sequence control, content control, and whether to view the materials in groups or individually. Students commented that the modules satisfied a variety of objectives including: as an advance organizer to acquire basic concepts; as a supplement to the lecture; for review; and in some instances as a replacement for lecture. Students strongly supported the use of real pathology images on IVI to supplement text information and/or reinforce learning. Thus different styles of learning and different abilities of students were accommodated by the IVI design and implementation. This was a conscious effort by the instructional designers.

The attainment of higher level learning is a continuous goal in medical education. Students reported that when modules were viewed prior to class, the time spent in lecture was used to synthesize information rather than merely obtain facts. Students expressed approval for using the case studies to attain higher level course objectives, e.g., to practice clinical problem solving based on patient history, integrate and apply basic concepts and principles, and integrate and synthesize previously learned material.

In summary, the multiple methods approach used in this study generated a body of relevant learner response data consistent with previous process study outcomes. Students demonstrated a high level of acceptance for the neuropathology IVI materials, different learner styles were accommodated by the design of the modules, and higher level objectives were facilitated by the design and implementation of the IVI modules. Thus, this study supports the increased application of interactive videodisc technology in the medical school curriculum to achieve the recommendations outlined in the GPEP Report. Successful IVI curricular integration must attend to issues that involve careful planning, monitoring, and follow up.

Specific Recommendations

1. Appropriate use of IVI should be integrated within the curriculum, not merely provided as an adjunct to learning.
2. IVI material should relate to content on exams and should incorporate feedback to the student.
3. IVI modules should incorporate learner control options that accommodate various learner styles.
4. Initial exposure to IVI modules should be strongly encouraged or required.
5. Group interactions (2-3 students/group) should be facilitated.
6. Students' perspectives on instructional issues should be solicited in order to design IVI units and plan implementation strategies to best meet the needs of the target student population.

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References

1. Muller, S. (Chairman). Physicians for the Twenty First Century; Report of the Project Panel on the General Professional Education of the Physician and College Preparation for Medicine. J. Med. Educ. 59, Part 2 (November 1984).
2. Borek, Deborah. Unchanging Dilemmas in American Medical Education. Acad. Med. 64 (1989): 240-244.
3. Piemme, T. E. Computer-assisted Learning and Evaluation in Medicine. J.A.M.A. 260 (1988): 367-372.
4. Nolte, J., Eller, P., Trynda, R. S. Stalking the Wild Asparagyrus: Learning Neuroanatomy Using an Interactive Videodisc System. In Research in Medical Education: 1987. Proceedings of the Twenty-Sixth Annual Conference. D. Dabney, compiler, pp. 193-196. Washington, D.C.: Association of American Medical Colleges, 1987.
5. Woods, J. W., Jones, R. R., Schoultz, T. W., Kuenz, M., Moore, R. L, Teaching Pathology in the 21st Century. Arch. Pathol. Lab. Med. 112 (1988): 852-856.
6. Xakellis, G., Gjerde, C. Evaluation by Second-Year Medical Students of Their Computer-Aided Instruction. Acad. Med. 65 (1990): 23-26.

7. Kramer, A. M., Polan, H. J. Uses and Advantages of Interactive Video in Medical Training. J. Med. Educ. 63 (1988): 643-644.
8. Jones, R.R., Schoultz, T.W. Teaching Pathology in the 21st Century: Assessment of Required Student Use of Interactive Videodiscs Designed to Teach Basic Pathology. Human Pathol. 21 (1990): 6-10.
9. Lovell, K., Haf, J., Hodgins, M., Development of Neuropathology Interactive Videodisc Instructional Units. Teaching and Learning in Medicine. 3 (1991): 156-158.
10. Hagler, P., Knowlton, J. Invalid Implicit Assumption in CBI Comparison Research. J. Compt.-Based Instr. 14 (Summer 1987): 84-88.
11. Patton, Michael Q. How to Use Qualitative Methods in Evaluation. Newberry Park, California: Sage Publications, 1987, p. 18.
12. Reeves, T. C. Research and Evaluation Models for the Study of Interactive Video. J. Compt.-Based Instr. 13 (Autumn 1986): 102-106.
13. Slee, E. J. A Review of the Research on Interactive Video. Paper presented at the Association for Educational Communications and Technology Annual Meeting, Dallas, Texas, February 1989.

Title:

Filmmaking and the Development of Cognitive Skills

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Introduction

As someone trained as a filmmaker, I often wonder how the years spent learning and practicing my craft have changed me. In recent years, I have become increasingly aware of instances when I find myself slipping into what I think of as my "filmmaker mode". As I pour over research articles in an attempt to see interrelationships and connections, revise a paper on my word processor, or pare down and organize data on a spreadsheet, I am reminded of the many hours I have spent in an editing room sifting through reels of film to find just the right combination of shots. I am perhaps most aware of this "filmmaker mode" when I am in a new place. I consciously begin to select a series of mental snapshots and to differentiate between the many layers of sound present around me. In essence, I break my surroundings down into discrete chunks of visual and aural data which later helps me remember what I have seen and heard in rich detail. These personal anecdotes suggest that the practice of filmmaking has changed me -- that it has in some small way altered the way I perceive and interact with the world around me.

Sol Worth (1973) was the first to note the potential cognitive effects of filmmaking and suggested that the practice of filmmaking could be harnessed as an educative experience in the classroom. Worth described the predominant use of film in the classroom -- film as a delivery system -- as a "substitute" for books and lectures. He further characterized the intent of this use of the medium as "learning through film" -- what the student is intended to learn is the content presented in the film. The second and, according to Worth, the most powerful use of film in the classroom, relates to how the medium works as a system of communication -- something Worth called "learning about media". Worth suggested that the skills developed through such an understanding, a set of skills referred to as "film literacy", would allow the learner to view the world in a new way:

> Filmmaking could become one of the important tools by which we allow and help the child as well as the adult to develop skill in building cognitive structures and in structuring reality in a creative, communicative way. Although we can teach *through film* [emphasis added], we must begin to understand how the structure of film itself and the visual modes, in general, structure our ways of organizing experience. (p. 302)

Theoretical Support

The notion that the act of filmmaking may change the filmmaker in important ways is, in part, explained by a body of theoretical work that describes ways humans are able to perceive and represent the world in a variety of symbolic forms or systems (Olson and Bruner, 1974; Salomon, 1979; Gardner, 1983). This work makes two basic claims. The first claim is that cognitive representation and processing are carried out in various symbolic modes. The second is that these cognitive operations can be influenced by the symbol systems employed by media (Clark and Salomon, 1986). For example, the act of writing a cogent essay draws upon different symbolic competencies than the act of composing a symphony or taking a photograph, because each of these mediated messages is cast in a different set of symbolic forms. (Gardner, 1983).

One of the most useful "symbol system" theories is one proposed by Salomon (1979) because Salomon makes an important link between symbol systems and media (Clark and Salomon, 1986). Salomon's theory suggests that both media and the human mind use symbols to represent, store, and manipulate information and that some of the symbol systems used in cognition are cultivated through the manipulation of the symbol systems employed by media.

Each symbolic competence is comprised of a set of cognitive skills that must be mastered in order for an individual to be fluent in that particular symbol system. Researchers like Gardner (1983) and Olson (1974) prefer to think of these various kinds of symbolic competencies as different forms of intelligence. In fact, Gardner identifies five different kinds of intelligence or symbolic competency: linguistic intelligence, musical intelligence, logical-mathematical intelligence, spatial intelligence, and bodily-kinesthetic intelligence. What cognitive skills might the act of filmmaking cultivate? Prior empirical work (Tidhar, 1984; Sutton-Smith, 1979) and a detailed examination of the cognitive tasks involved in filmmaking suggests that among the most likely kinds of cognitive abilities to be developed from the practice of filmmaking are spatial abilities and skills of abstract reasoning.

Filmmaking: A Conceptual Analysis

Filmmaking is a difficult process to examine because it involves many diverse tasks and is often carried out by many skilled craftspersons such as directors, actors, camerapersons, and editors. This is particularly true within the professional feature film industry where it is difficult to describe any one individual as a filmmaker. The vast majority of films made, however, are not feature films and are not characterized by such a large and diverse labor force. These films are often made by individuals who are responsible for all phases of production from initial concept through shooting and editing to finished film. Under such conditions, the term "filmmaker" more accurately describes the people involved.

In its basic form, filmmaking can be seen as two fundamental processes: the collection and crafting of discrete visual and aural elements into communication -- a series of messages that conveys meaning (Eisenstein, 1949). In film parlance, the collection stage is referred to as "filming" or "cinematography". The crafting stage is called "editing". Both stages are particularly complex because of the cognitive visualization requirements of the tasks. It is important to note that such a definition suggests that filmmaking need not necessarily occur with conventional motion picture cameras and editing equipment. The sort of collecting and crafting of images and sound described here can be carried out with video equipment, with a still camera and an audio cassette recorder, or even with the latest in microcomputer technology.

During the collection stage the filmmaker must carefully visualize the way a finished shot will look. This includes not only visualizing the content of the shot: the setting, the time of day, season, the movement of objects within the frame, but also the relationship of the frame to this visual content. Should the frame emphasize certain objects and if so how? For example, should the camera shoot the scene from a high or low angle? Should the camera shoot the scene from the front or back or perhaps from the side? Each of these options must be carefully imagined.

The filmmaker's visualization task is made more complex by the fact that the camera and scene being shot may not be static. For example, the camera may move towards an actor as the actor simultaneously moves towards the camera or the camera may "crane" into the air as an actor moves away from the camera. This sort of complex visualization requires the ability to mentally picture an object or objects from any conceivable vantage point. In the simplest case, both the vantage point and the object are static. In the most complex case, both the vantage point and the object are moving independently of each other.

The crafting phase of filmmaking, often referred to as editing, entails the assembly of individual shots and corresponding sound (Pudovkin, 1958). It is during this stage of production that the raw data are reviewed and distilled into the filmmaker's original conception. It is during the assemble stage that a filmmaker's visualization ability is tested once again. The filmmaker must organize the shots in such a way as to ensure that each edit appears invisible. This is done by making sure that the finished scene creates the illusion of a continuous flow of action. This means that the many takes of a scene that were shot sequentially must be edited to appear as if they were shot at the same time. To create such a continuity of action, the filmmaker must be able to visualize the finished scene from beginning to end as it will appear in the finished movie. The visualization task called upon at this stage is similar to the one required at the collection stage. The filmmaker must have the ability to imagine the objects in the scene as they move relative to each other over time. In addition, the filmmaker must be able to visualize these changes from different vantage points.

An actual editing problem illustrates the complexity of the visualization task. An editor must edit together four different shots of a car smashing into a passenger train. Shot one shows a long shot of a car hurtling towards a level crossing as a high speed passenger train approaches in the background. Shot two is taken from the point of view of the driver of the car. We see the driver's hands thrown up in fear as the train suddenly appears through the windshield. Shot three is a close up of the driver as he shields his face. Shot four is a long shot of the car crashing into the train and exploding in a huge ball of fire. In order for these shots to flow smoothly together, the spatial relationship between the car, the train, and the actor must be the same from edit to edit. The editor must be able to visualize these constantly changing spatial relationships as he or she imagines the finished scene.

Another important cognitive skill is called upon during the editing process. In the early stages, film editing is, essentially, an exercise in visual organization. Images must be identified and then organized into a workable conceptual framework. This organizing phase, in essence, becomes an exercise in visual concept classification. Suitable categories must be formulated and then each set of images (a shot) must be classified according to the framework.

For example, shots may be classified according to the type of camera movement used, the type of coverage (long shot, close-up, medium shot), the type of action within the shot, the location of the shot or simply the overall quality of the shot. Once a framework has been created and the raw footage broken down and organized, the filmmaker begins to assemble the individual shots into scenes. Since the ability to organize visual data is apparently linked most with editing, while the ability to visualize spatial forms is called upon in both editing and cinematography, it would seem likely that skill in spatial visualization is more likely to be cultivated through an initial filmmaking experience.

A Review of Past Studies

Several studies have specifically investigated the effect of filmmaking on the cultivation of cognitive skills. Tidhar (1984) demonstrated that junior high school students who were taught filmmaking skills showed significant improvement on measures of logical inference, spatial aptitude, and conceptual focusing as compared to a non-filmmaking control group.

Eighty-seven fifth grade students were randomly assigned to four different 55 hour filmmaking courses. The first group was taught photography only, the second script writing and photography, the third photography and editing, and the forth was taught editing only. The course lasted 10 weeks and consisted of two 3 hour sessions per week. A series of 8 tests, including the DAT (1980) space relations and abstract reasoning tests were administered to the students 3 weeks after the completion of the film course. Through factor analysis, the 8 scores were combined into measures of logical inference, spatial aptitude and conceptual focusing. All filmmaking treatments and particularly the editing group, resulted in significant increases in scores as compared to a control group which did not receive the treatment.

A three year study that investigated the New York City Young Filmmakers Program (Sutton-Smith, 1979, Sutton-Smith, Eadie, and Griffin, 1983) provided evidence that filmmaking had a significant educational impact upon children. One hundred and fifty students ages 5 to 16 years and of varying ethnic and socio-economic status participated in the study. Approximately 300 short films were produced. The major hypothesis of the study was that children who received intense training and practice in filmmaking would demonstrate significant gains in their ability to organize and manage internal visual imagery.

Impact was assessed along three dimensions: perceptual, cognitive and personal. Perceptual competencies were defined in terms of the learner's ability to notice visual details and to discern hidden aspects of reality which may not have been so obvious beforehand. The Witkin's Embedded Figures Test (1954) and the Goodenough-Harris Draw a Man Test (1961) were used as measures of perceptual competence. Cognitive organization was measured by performance on the Wechsler Intelligence Scale for Children (WISC) (1950). In particular, the sections dealing with picture arrangement/picture completion and block designs were emphasized. Personal development was equated with creativity which was measured by performance on the figural section of the Torrance creative thinking test and the individual's sense off personal autonomy which was measured by performance on a locus of control test.

Results of the study showed that significant changes in cognitive measures were directly related to the number of films made and the amount of time spent at the workshop. Those completing at least one film showed significant increases in their performance on the Block Design subtest of the WISC and a significant internal shift on the locus of control measure. In addition, a majority of the children who participated in the filmmaking workshop showed significant gains in scores on the Embedded Figures Test. Another important finding was related to the characteristics of learners who made at least one film compared with those who dropped out. Those who completed one or more films had significantly higher scores on the WISC Picture Completion subtest and the Object Assembly subtest; had a better memory for films that they had observed being made in New York; and were more often the youngest of a small family or the eldest of a large family.

Both the Tidhar (1983) and the Sutton-Smith (1979) studies suggested that the cultivation of spatial and abstract reasoning skills were among the important cognitive benefits from prolonged filmmaking practice. Both studies examined the cognitive effects of filmmaking on relatively young subjects -- between the ages of 6-16. Two important weaknesses of these studies should be noted. First, both studies relied on relatively weak treatments -- approximately 50 to 75 hours of filmmaking practice. Second, both studies failed to develop a compelling rationale for the cognitive measures used.

Spatial Skills and Abstract Reasoning

Spatial ability (also referred to in the literature as spatial intelligence) is "skill in representing, transforming, generating, and recalling symbolic, non linguistic information (Linn and Petersen,1985, p 1482). Linn and Petersen (1985) contend that spatial ability is comprised of three basic skills: spatial perception, mental rotation, and spatial visualization.

Research studies have shown that success in certain academic subject areas and vocations is, in part, a function of an individual's spatial aptitude. Spatial scores are directly related to performance in courses such as plane geometry, drawing, mathematics, and shop (McGee, 1979). Spatial aptitude has also been shown to be a good predictor of success in such occupations as architecture, computer science, art and engineering (McGee, 1979).

The present study focuses upon one of the most complex spatial abilities, spatial visualization. Spatial visualization tasks involve a number of steps and must be solved by using "an analytic combination of visual and non-visual strategies" (Thomson, 1989, p. 17). Spatial visualization subsumes spatial perception and mental rotation. Spatial perception involves the "comprehension of the arrangement of elements within a visual stimulus pattern and the ability to remain unconfused by the changing orientation in which a spatial configuration may be presented" (McGee, 1979, p. 893). Mental rotation is the ability to mentally manipulate the orientation of spatial forms.

Successful spatial visualization requires subjects to carefully analyze a problem visually and select an appropriate solution strategy. It is the multi-step, multi-strategy, analytic characteristic of the task which distinguishes spatial visualization from other spatial skills (Linn and Petersen, 1985).

Abstract reasoning is the ability to determine relationships between visually presented, non-semantic information (Anastasi, 1982, p. 290). Formalized tasks of abstract reasoning require the ability to analyze a set of apparently disparate patterns, create a meaningful context for the patterns, and then select like patterns for inclusion in the set (Cronbach, 1960).

The ability to create a meaningful context for visual information appears to be important during the editing stage of filmmaking. Editing entails the shaping and structuring of vast amounts of visual data in the form of hundreds or even thousands of individual shots. The filmmaker needs a coherent conceptual framework to aid in the organization of the many shots.

Rationale For Study

Determining whether spatial skills and skills of abstract reasoning are cultivated through filmmaking is important for four reasons.First, the study may yield support for or against the inclusion of filmmaking within high school and university curricula. There are currently more than 3000 film courses at 600 universities and colleges across North America (Bohn and Stromgren, 1987). Since the vast majority of students enrolled in film production courses never pursue a professional filmmaking career, it may be possible to identify the development of certain cognitive skills as a valuable by-product of making movies within an educational setting. In addition, the rapid proliferation of inexpensive home video equipment has meant that filmmaking is now an activity that millions engage in. How might these individuals expect to be affected by their hobby? Several studies already suggest that filmmaking practice is beneficial by showing that it cultivates certain cognitive skills. For example, Tidhar (1983) showed that a 55 hour filmmaking course led to significant increases on measures of logical inference, spatial ability, and conceptual focusing among junior high school students.

Second, the skills gleaned from making films may be applied to apparently more complex or more abstract activities -- such as essay writing (Constanzo, 1985). In other words, filmmaking can be employed as an instructional intervention. A knowledge of the skills filmmaking cultivates will help educators to design such interventions. Filmmaking has been used as a means of facilitating high school students' appreciation and understanding of literary structure (Cox, 1985). Filmmaking has also proved to be a useful means of helping students engage more enthusiastically in the revision of written work (Primeau, 1974). Since revision (editing) is such a self-evident part of filmmaking, students exposed to it seem more willing to rework other forms of self-expression such as term papers and essays. Also, the production of a short film on the American Civil War, for example, may be a more effective means of offering certain students the opportunity to gather and synthesize knowledge about the topic than writing a conventional term paper would (Cox, 1985).

Given that filmmaking can serve as an instructional intervention, it is conceivable that aspects of filmmaking practice could be incorporated as part of a computer-based lesson or data-base management program. For example, the film-editing process could be simulated as part of a lesson designed to teach learners about dramatic structure in short stories. Learners would be able to manipulate (reorder, shorten, lengthen) sections of a short story and then view the result -- just as a film editor would cut a short film. Computer-based data base management programs might be successfully manipulated along a film-editing model. Information on a particular topic could be stored as a specific shot and then reworked into scenes that incorporate a number of specific entries. Other educational applications of filmmaking can be identified and developed.

Third, the study may lead to a better understanding of the filmmaking process itself which in turn may suggest new ways of teaching filmmaking. If certain cognitive skills are fundamental to the making of good films then perhaps these skills need to be stressed during any filmmaking course.

Fourth, the perspectives and methods used to understand and harness the practice of filmmaking as an educational activity may be successfully employed with other types of mediated practice such as computer programming and data-base creation and management. In other words, viewing the activity of filmmaking as an educative experience, redefines the way the field of educational technology views the role of media in education. It suggests that media are not benign devices through which instructional content passes but devices that liberate learners -- that allow them to experience and shape the world around them in new ways, perform unique tasks, and possibly acquire unique abilities previously unattainable or, at least, acquire generic skills more easily or in other ways. This perspective has important implications for an educational system that largely ignores the possibility that beneficial side-effects accrue from learning activities (Perkins and Salomon, 1987).

Hypotheses

In order to determine whether an intensive introductory course in filmmaking cultivates spatial visualization and abstract reasoning, and whether success in filmmaking is directly related to one's level of spatial visualization and abstract reasoning the following research hypotheses were formulated:

1) Learners who receive intensive training and practice in filmmaking will show greater improvement, over time, in their ability to perform tasks of spatial visualization and abstract reasoning compared with learners who do not receive training in filmmaking.
2) A subject's spatial visualization and abstract reasoning ability is directly related to the quality of film produced.
3) A subject's increase in spatial visualization ability is directly related to time spent editing and time spent engaged in cinematography.
4) A subject's increase in abstract reasoning ability is directly related to time spent editing.

Method

In order to test the research hypotheses, a quasi-experimental, nonequivalent control group design was employed. Subjects were conveniently selected from among first and second year university students (the equivalent of sophomores and juniors at an American university) at the University of Windsor in Windsor, Ontario. An intensive introductory 8 month course in 16mm film production served as the treatment while a comparison group received no film or media instruction. Subjects were administered a series of two tests four times during the 8 month period. The tests were given approximately every 8 weeks. The tests measured subjects' spatial visualization and abstract reasoning ability. The two measures were taken from the Differential Aptitude Tests (1980). The groups were compared with respect to their performance on the tests as measured over the 8 month period. A detailed account of the amount of time spent by subjects in the treatment group on various filmmaking activities was kept and an assessment of the quality of the student films produced was also made.

Results

There appeared to be compelling evidence to suggest that the introductory filmmaking course had no effect upon the cultivation of spatial visualization or abstract reasoning. First, it was the comparison group and not the treatment group that increased the most with respect to level of spatial visualization. Second, there was no significant difference between the groups with respect to their increase in abstract reasoning.

These apparently unequivocal results, however, are muddied by a number of factors. To begin with, if the treatment were ineffectual, one would expect no difference between the groups with respect to the degree of increase in spatial visualization. A learning effect is one plausible explanation for the rapid increase in the comparison groups' level of spatial visualization. Subjects were increasingly able to remember the answers to those question they found easy and spend more time working on those items of higher difficulty Given the nature of the course material and the other courses comparison group subjects were taking, it is unlikely that this increase can be attributed to anything other than repeated exposure to the same instrument. In addition, interview data suggested that subjects felt they were increasingly better able to "psych out" the test.

A partial ceiling effect is a plausible explanation for the comparison groups *more* rapid improvement relative the treatment group. The treatment group's average score on the first trial was 43.1 out of a possible 60. The comparison group scored an average of 39. By the second trial the treatment group scored 47.8 and the comparison group scored 45.1. By the third trial, the treatment group scored 48.2 and the comparison group 46.7.

It could be argued that by the time of the second trial, a significant portion of the treatment group scored sufficiently well that there was little room for improvement on the subsequent two trials. The comparison group, on the other hand, scored below the treatment group on the first two trials and thus had more room for improvement. As the results show, the comparison group actually caught up to the treatment group by the fourth trial scoring 49.1 compared with 49.6 for the treatment group.

Unlike level of spatial visualization, there were no significant differences between the groups with respect to increases in level of abstract reasoning. As with spatial visualization, however, the increases in abstract reasoning may be attributed to a learning effect from the instrument. Both groups increased by nearly identical amounts: 36.9 to 40.0 for the treatment group and 37.2 to 40.7 for the comparison group. There is no evidence of a ceiling effect with the abstract reasoning measure.

These results contradict those of the Tidhar and Sutton-Smith studies. It could be that age is a salient variable in the development of both spatial visualization and abstract reasoning. Both the Tidhar and Sutton-Smith studies examined the cognitive impact of filmmaking on subjects aged 6 to 16. In both cases subjects who received training in filmmaking displayed significant improvement in their performance on spatial and abstract reasoning tests. The current study, however, deals with college-aged subjects. Perhaps the younger subjects of the Tidhar and Sutton-Smith studies were at an age when their cognitive skills were developing rapidly and may have been susceptible to interventions that might have quickened this cognitive development.

There is evidence to suggest that skill of mental rotation (an important element in spatial visualization) begins to develop rapidly in children around the age of 8. Prior to this age, children make frequent mistakes in their attempts to predict the appearance of rotated objects (Inhelder & Piaget, 1958). By the time children reach the age of 10, they are able to mentally rotate objects nearly as well as adults (Kail, Pelligrino, and Carter, 1980) although the rate of mental rotation approximately doubles between this age and adulthood (Corbollis, 1983).

If the above is true, possibly the college-aged subjects of the present study, as a group, already possessed well developed and stable spatial visualizations and abstract reasoning skills – skills not likely to be affected by any instructional intervention. The increases that the filmmaking and non-filmmaking subjects did experience were possibly due to their increasing familiarity with the test and not effects of filmmaking.

It is possible, however, that the treatment group was able to perform the spatial visualization and abstract reasoning tasks at an increasingly faster rate compared to the comparison group. This follows from Corbollis' (1983) assertion that change in spatial visualization skill for teenagers and adults is reflected solely in terms of speed of execution. Unfortunately, time on task data was not collected during the testing sessions.

The other focus of the study was to determine the extent to which the cognitive skills of spatial visualization and abstract reasoning were an integral part of the filmmaking process. Certainly the results appear unequivocal. Neither spatial visualization or abstract reasoning was positively associated with course grade or final film grade. In addition, time spent editing and/or filming was not related to increases in spatial visualization or abstract reasoning.

It may be that with filmmakers of this age other factors such as effort (time spent making films was directly related to course grade) and conceptual preparation (the preparation of a clear and creative shooting script) are as or more important in determining whether a high quality student film is produced but this can not be established given the data at hand.

Another plausible explanation for the low correlation between level of spatial visualization and abstract reasoning and a subject's final grade should be noted. A close examination of the final grade reports showed that non filmmaking activities, such as essays, scripts, and exams accounted for more of the final grade than filmmaking assignments. In other words, the final course grade was not a good measure of filmmaking ability.

Implications and Suggestions For Future Research

The results of this study should not deter future research into the effects of active expression through visual media. Nor should these results call into question the inclusion of filmmaking in high school and university curricula; however, further investigations of filmmaking and its cultivation of spatial and abstract reasoning skills in adults may not to be fruitful. However, additional work is necessary to better understand the relationship between these cognitive skills and filmmaking. Future research should also strive to identify more meaningful ways in which the activity of filmmaking changes the filmmaker. With this information in hand, filmmaking courses can be more wisely incorporated into school curricula.

Clearly, there is need for conceptual research to help articulate meaningful dimensions of impact. Such research would form the basis for further empirical work. Within the cognitive domain, what other skills might likely be enhanced by the manipulation of visual and aural information. Perhaps filmmaking effects the way visual data are stored and retrieved.

These questions have greater importance now that small format video technology is so readily accessible. Millions of people experience significant parts of their lives – their vacations, their child's first birthday, their daughter's wedding – by peering through the viewfinder of a video camera. They then "relive" these experiences by repeated showings of the images and sounds they have collected. How are one's perceptions of these experiences altered by the technology used to collect and view them?

It is also important to explore the effect of filmmaking in ways other than cognitive skill development or in terms of how it shapes and alters our perceptions. For example, how might filmmaking develop team building skills or facilitation skills. How might filmmaking encourage dialogue within a community? During the late 1960's and early 1970's, the National Film Board of Canada embarked on an ambitious plan to teach filmmaking to Canadian native groups. The natives used their new skills to produce films about their goals and aspirations and the many problems they faced. The project, in essence, acted as a needs assessment exercise for the natives. It facilitated discussion among the native community and helped the community to identify problems and possible solutions.

Another related and important question is the role media production should play in a media literacy curriculum. The province of Ontario, for example, has recently completed a major high school curriculum initiative in the area of media literacy (Ontario Ministry of Education, 1989). The report suggests that "hands-on" media experience may facilitate the development of students' overall understanding of how the media affect their lives. However, more work needs to be done to confirm this and determine the kinds of media production experiences best suited to this kind of curriculum objective.

In summary, despite the non-significant findings of this study it is important that we realize the value of media not solely in terms of delivering instructional content. We need to see media as instruments that allow learners to engage in unique and educative activities and that allow learners to experience the world around them in new and exciting ways.

References

Anastasi, A. (1982). *Psychological Testing*. New York: Macmillan.

Bohn, W. T., & Stromgren, R. L. (1987). *Light and Shadows: A History of Motion Pictures*. Mountain View, CA: Mayfield.

Clark, R. E., & Salomon, G. (1986). Media in teaching. In M. C. Wittrock (Ed.) *Handbook of research on teaching: Third edition: A project of the American Educational Research Association* (pp. 464-478). New York: Macmillan.

Constanzo, W. V. (1985). Fiction into films: learning literature with a movie camera. *Teaching English in the Two-year College, 12*(1), 52-56.

Corballis, M. C. (1982). Mental rotation: Anatomy of a paradigm. In M. Potegal (Ed.). *Spatial Abilities: Development and Psychological Foundations*. New York: Academic Press.

Cox, C. (1985). Filmmaking as a composing process. *Language Arts*, *62*(1), 60-69.

Cronbach, L. J. (1960). *Essentials of Psychological Testing*. New York: Harper and Row

Differential Aptitude Test (1980). The Psychological Corporation.

Eisenstein, S. (1949). *Film Form: Essays in Film Theory*. New York: Meridian Books.

Emerick, L. (1986). Lights! Camera! Learn! *Gifted Child Today* , *9*(5), 29-31.

Gardner, H. (1983). *Frames of Mind*. New York: Basic Books.

Goodenough, D. R. & Karp, S. (1961). A field dependence and intellectual functioning. *Journal of Abnormal and Social Psychology, 63*, 241-279.

Inhelder & Piaget, (1958). *The growth of logical thinking from childhood to adolescence*. New York: Basic Books.

Kail, R., Pellegrino, J., & Carter, P. (1980). Developmental changes in mental rotation. *Journal of Experimental Child Psychology*, *29*, 102-116.

Linn, M. C. (1985). The cognitive consequences of programming instruction in classrooms. *Educational Researcher*, *14* (5), 14-29.

Linn, M. C. & Petersen A. C., (1985). Emergence and characterization of sex differences in spatial ability: A meta-analysis. *Child Development*, 56, 1479-1498.

McGee, M. G. (1979). *Human Spatial Abilities: Sources of Sex Differences*. New York: Praeger.

Olson, D. R., (1974). Media models and symbolic systems: The forms of expression and communication. In D.R. Olson (Ed.), *Media and Symbols: The Forms of Expression Communication , and Education* (73rd Yearbook of the National Society of the Study of Education). Chicago: University of Chicago Press.

Olson, D. R., & Bruner, J., (1974). *Learning through experience and learning through media.* In D. R. Olson (Ed.), op cit.

Ontario Ministry of Education. (1989). *Media Literacy* (Ministry Publication No. 88-035). Toronto, Ontario: Queen's Printer.

Perkins, D. N. & Salomon, G. (1987). Transfer of cognitive skills from programming: When and how? *Journal of Educational Computing Research*, 3(2), 149-169.

Primeau, R. (1974). Film editing and the revision process: Student as self-editor. *College Composition and Communication* , *25*, 405-10.

Pudovkin, V. I. (1958). *Film Technique and Film Acting*. Grove Press: New York.

Salomon, G. (1972). Can we affect cognitive skill through visual media? *A.V. Communication Review*, *20*, 401-22.

Salomon, G. (1974). Internalization of filmic schematic operations in interaction with learner's aptitudes. *Journal of Educational Psychology*, *66*, 499-511.

Salomon, G. (1979). *Interaction of Media, Cognition and Learning*. Jossey Bass, San Francisco, CA.

Salomon, G. (1984). Television literacy and television vs. literacy. *Journal of Visual and Verbal Languaging,* Fall, 7-16.

Salomon, G., & Perkins, D. N. (1987). Transfer of cognitive skills form programming: When and how? *Journal of Educational Computing Research*, *3*(2), 149-169.

Salomon, G., & Cohen A. A. (1977). Television formats mastery of mental skills, and technology in education. *Journal of Educational Psychology*, *69*(5), 612-619.

Seashore, H. G., Wesman, A. G., & Doppelt, J. E. (1950). The standardization of the Weschler Intelligence Scale For Children. *Journal of Consulting Psychology, 14*, 94-110.

Sutton-Smith, B. (1979). A developmental psychology of childrens' filmmaking: Report to Ford Foundation. (ERIC Document Reproduction Service No. ED 148 330)

Sutton-Smith, B., Eadie, F., & Griffin, M. (1983). Filmmaking by young filmmakers. *Studies in Visual Communication*, *9*, 65-75.

Thomson, V. L. R. (1989). *Spatial ability and computers: Elementary children"s use of spatially defined microcomputer software*. Unpublished doctoral dissertation, University of Toronto, Toronto.

Tidhar, C. E. (1984). Children communicating in cinematic codes: Effects on cognitive skills. *Journal of Educational Psychology*, *76*, 957-665.

Witkin, H. A. et al. (1954). *Personality Through Perception: An Experimental Study*. New York: Harper & Row.

Worth, S. (1974). The uses of film in education. In D. R. Olson (Ed.), In D.R. Olson (Ed.), *Media and Symbols: The Forms of Expression, Communication, and Education* (73rd Yearbook of the National Society of the Study of Education). Chicago: University of Chicago Press.

Title:

Effects of Learner Control Over Feedback in Computer-Based Instruction

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Effects of Learner Control over Feedback in Computer-based Instruction

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Abstract

Although both learner control and feedback have been heavily researched, very little research has been conducted on giving learners control over the feedback which they receive. The purpose of this study was to examine the effect of learner control over feedback in a CAI lesson. Subjects used one of four CAI programs which provided either program control or learner control over verification or elaboration feedback. Results indicated that subjects who received elaboration feedback during instruction performed better than students who received verification feedback. Type of control did not have a significant influence on performance. Implications for the design of CAI are discussed.

Introduction

While a great deal of research has been conducted on learner control and on feedback, few studies have been conducted to determine if learner control of feedback will have an effect on student performance and attitude. Computers now make it possible to allow learners to control the amount of feedback in instruction. But it is not clear whether giving learners control of feedback is beneficial. Some writers have suggested that the "mere illusion of control" significantly improves motivation and performance (Perlmuter and Monty, 1977), while others have concluded "there is little support from the research literature that offering students control will lead to increased learning" (Carrier, 1984, p. 17).

Several researchers report advantages for allowing learners to have control in computer-assisted instruction. Learner control over the instructional strategy of a CAI program has positively influenced retention of information and student interest (Newkirk, 1973). Learner control over review options (Kinzie, Sullivan, & Berdel, 1989) and contextual properties (Ross & Morrison, 1989) in CAI lessons has significantly increased test performance. Hansen (1974) found that learner control over feedback in a CAI lesson decreased student anxiety about learning, while others have reported that both feedback and learner control in CAI increased student performance and attitude (Schloss, Wisniewski, & Cartwright, 1988; Steinberg, Baskin, & Hofer, 1986).

According to Clariana, Ross, and Morrison (1991) feedback is an important variable that is often ignored in CAI. Researchers have reported that feedback increases learner performance and reduces program errors (Anderson, Kulhavy & Andre, 1972; Kulhavy, 1977; Kulhavy, Yekovich, & Dyer, 1979).

Feedback is a unit of information with two components, verification and elaboration (Kulhavy & Stock, 1989). Verification is the simple dichotomous judgment that an initial response was right or wrong. Elaboration consists of all substantive information contained in the feedback message. Collins, Carnine & Gersten (1987) demonstrated that when verification and elaboration were given in CAI, performance was significantly higher for elaboration, while the time to complete was similar. In addition, a meta-analysis conducted by Bangert-Drowns, Kulik, Kulik, and Morgan (1991) indicated that elaboration feedback produced greater effects for learning than verification feedback.

The purpose of this study was to examine the effect of learner control over feedback in computer-assisted instruction. The independent variables were type of control (learner or program) and level of feedback (verification or elaboration). The dependent variables were performance on a posttest, attitude toward the program, and time to study feedback.

Method

Subjects

Subjects were 100 undergraduate education majors enrolled in an educational psychology class at a large southwestern university. Data for 93 out of the original 100 subjects were included in the analyses of the results because scores on one or more measures were unavailable for the remaining seven subjects.

Materials

Materials used in this study were four CAI lessons, a posttest, and an attitude questionnaire. The CAI lessons were developed using a software package called the Presenter (Behrens & Stock, 1990). All lessons provided the same information, examples, and practice on the concepts of reliability and validity. The lessons were based on the text Topics in Measurement: Reliability and Validity by Dick & Hagerty (1971). Information and examples were presented in sections of five screens of text, followed by eight, five-alternative, multiple-choice questions. This cycle continued for a total of 25 screens of text and 40 questions.

The differences in the CAI lessons were based on type of control (program and learner) and level of feedback (verification and elaboration). Under program control, the computer program administered one of the two feedback conditions automatically. Under learner control, subjects decided if they wanted to receive feedback. Under the condition of verification, a learner was told only if a response was correct or incorrect; while under elaboration, a learner was told if a response was correct or not, the correct answer, and a short explanation.

Subjects using the program control/verification lesson were always provided with the feedback message "yes, you are correct" or "no, you are incorrect" after each practice question. Subjects using the learner control/verification lesson were asked "would you like to check your answer?" after each question. If the response was, "yes", then the appropriate verification feedback was presented. If the response was, "no", the program continued with the next question or screen of text.

Subjects using the program control/elaboration lesson always received verification information, followed by the correct answer and a short explanation after each practice question. Subjects using the learner control/elaboration lesson were asked "would you like to check your answer?" after each question. If the response was, "yes", verification appeared as described above. The lesson then asked, "would you like an explanation?" If the response was, "yes", the correct answer and an explanation appeared before the program continued. If the response was "no", the lesson continued with the next question or screen of text.

In addition to the four CAI lessons, a posttest and an attitude questionnaire were developed. The posttest consisted of the same 40 questions previously given as practice but presented in a random order. The reliability of the posttest was calculated at .69 using the Kuder-Richardson 20 formula. The attitude questionnaire consisted of ten items measuring student satisfaction, enjoyment, perception of control, and feeling toward feedback. The questionnaire used a five point Likert-type scale. Both measures were administered on the computer. In addition, the computer automatically recorded the number of seconds each subject spent studying feedback messages.

Procedure

Before subjects arrived to participate in the study, an experimenter prepared the computer laboratory by installing one of the four lessons into each computer. Upon arrival to the computer room, each subject was randomly assigned to one of the four experimental conditions. All four of the conditions were present at each experimental session.

The experimenter gave a short introduction on general procedures and told subjects that instructions were included in the program. They were not told that the programs were different. Subjects were told that the lesson was on reliability and validity and stressed the importance of the material for them as future teachers. Subjects were also told that they would have to pass a test at the end of the lesson in order to receive points toward their final course grade. Subjects then proceeded with their individual lessons. Upon completion of the lesson, each subject completed the attitude questionnaire and the posttest on the computer. They were given as much time as they needed to complete the lessons and the criterion measures. Most subjects completed the study within a 50-minute class period.

Design and Data Analysis

The design was a 2 x 2 factorial with type of control (learner or program) and level of feedback (verification or elaboration) as the independent variables. The dependent variables were performance, attitude, and feedback study time.

Analysis of variance (ANOVA) was used to test for differences between groups on performance and feedback study time. A multiple analysis of variance (MANOVA) was used to test for differences between groups on the attitude questionnaire. The MANOVA was followed by univariate analysis for each question. An alpha level of .05 was set for all statistical tests. In addition, effect sizes (ES) were calculated.

Results

Performance

Mean scores and standard deviations for performance can be found in Table 1. These data indicate that the mean for subjects who received verification feedback was 25.11, while the mean for subjects who received elaboration feedback was 31.15. The mean score for the program control group was 28.59 and the mean score for the learner control group was 27.67.

Analysis of the posttest data indicated that level of feedback had a significant effect on performance F(1, 89) = 39.47, $p < .05$, MSe = 21.41, ES = 1.09. Subjects who received elaboration feedback performed better than those receiving verification feedback, regardless of the type of control provided. The difference for type of control and the feedback by control interaction were not significant.

Table 1
Means and Standard Deviations for Performance

		Type of Feedback		
Control		Verification	Elaboration	Totals
Program	M	25.17	32.00	28.59
	SD	4.72	3.66	4.19
Learner	M	25.04	30.29	27.67
	SD	4.79	5.18	4.98
Totals	M	25.11	31.15	28.15
	SD	4.76	4.42	4.63

Highest possible score was 40. Cell sizes were 24 for learner Control/elaboration and 23 for the other three conditions.

Attitude

Analysis of the 10-item attitude questionnaire data revealed a significant MANOVA effect for level of feedback, F(10, 80) = 4.93, $p < .05$. Follow-up univariate analyses indicated a significant difference between feedback conditions for item 10 (I would have liked to have more feedback about my answers), F(1, 89) = 39.48, $p < .05$, MSe = 1.04, ES = .55. Subjects who received verification (M = 1.35, SD = 0.71) indicated a greater desire to receive more feedback than those who received elaboration (M = 2.66, SD = 1.22). No other significant differences were found on the attitude questionnaire.

Feedback Study Time

The means and standard deviations for feedback study time were calculated in seconds. The largest differences in feedback study time were between subjects who received verification (M = 70.96, SD = 20.56) and those who received elaboration (M = 287.67, SD = 124.61). The mean for subjects who received program control was 165.07 (SD = 152.35) and the mean for those who received learner control was 195.76 (SD = 130.23).

Analysis of the data for feedback study time revealed a significant effect for level of feedback, $F(1, 89) = 132.60$, $p <. 05$, $MSe = 8225.63$, ES = .75. Subjects who received elaboration spent an average of 217 seconds more when studying feedback than subjects who received verification. Type of control did not significantly affect feedback study time.

Discussion

The purpose of this study was to investigate the effects of learner control over feedback in an instructional computer program. Results suggest that students who receive elaboration feedback during instruction will perform better than students who receive verification feedback. This is consistent with other research which indicates that elaboration, rather than verification, produces greater effects in learning (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991; Collins, Carnine & Gersten, 1987).

There are several possible reasons why elaboration affected performance in the current study. One likely reason is that performance was improved due to the increased amount of information in the elaborated feedback message. Students who received elaboration were provided with the correct answer and an explanation of that answer after each practice question. However, subjects in the verification condition were only told whether their answers were correct or incorrect. It is likely that students who received elaboration used this additional information to correct errors made on practice items.

Another factor that may have contributed to the positive effect for elaboration is the increased in time spent in studying feedback. Students who received elaboration spent more time studying feedback than those who received verification. Additionally, students who received verification indicated a desire to have more feedback during instruction.

The results of this study suggest some implications for the design of CAI. Instructional designers should consider providing different feedback messages in CAI lessons depending on student responses. Verification feedback could be provided to students when their initial response to an item is correct, but it seems vital to provide elaborated feedback when an initial response if incorrect. CAI has the capability to provide differing feedback messages depending upon student responses.

The current study also has some implications for future research on feedback and learner control. Future studies should investigate whether different feedback messages will increase performance when the feedback is based on student responses. Research on the effect of verification and elaboration feedback should be conducted on differing learning outcomes. Furthermore, future research should examine if learner control based on student responses during practice will affect performance. Implementation of these suggestions will assist us in determining the conditions under which different types of feedback and learner control provide the greatest benefits.

References

Anderson, R. C., Kulhavy, R. W., & Andre, T. (1972). Conditions under which feedback facilitates learning from programmed lessons. Journal of Educational Psychology, 63, 186-188.

Bangert-Drowns, R. L., Kulik, C. C., Kulik, J. A., & Morgan M. (1991). The instructional effect of feedback in test-like events. Review of Educational Research, 61, 2, 213-238.

Behrens, J. T., & Stock, W. A. (1990). PRESENTER: Microcomputer programs for text-based experiments. Technical Report ZN-16, Instructional Science Research Facility, Arizona State University, Tempe, AZ 85287-0611.

Carrier, C. (1984). Do learners make good choices? Instructional Innovator, 29(2), 15-17, 48.

Clariana, R. B., Ross, S. M. & Morrison, G. R. (1991). The effects of different feedback strategies using computer-administered multiple-choice questions as instruction. Educational Technology Research & Development, 39, 5-17.

Collins, M. Carnine, D., & Gersten, R. (1987). Elaborated corrective feedback and the acquisition of reasoning skills: A study of computer-assisted instruction. Exceptional Children, 54, 254-262.

Dick, W., & Hagerty, N. (1971). Topics in measurement: Reliability and validity. New York: McGraw-Hill Book Company.

Hansen, J. B. (1974). Effects of feedback, learner control, and cognitive abilities on state anxiety and performance in a CAI task. Journal of Educational Psychology, 66, 247-254.

Kinzie, M. B., Sullivan, H. J., & Berdel, R. L. (1988). Learner control and achievement in science computer-assisted instruction. Journal of Educational Psychology, 80, 299-303.

Kulhavy, R. W. (1977). Feedback in written instruction. Review of Educational Research, 47, 211-232.

Kulhavy, R. W., & Stock, W. A. (1989). Feedback in written instruction: The place of response certitude. Educational Psychology Review, 1, 279-308.

Kulhavy, R. W., Yekovich, F. R., & Dyer, J. W. (1979). Feedback and content review in programmed instruction. Contemporary Educational Psychology, 4, 91-98.

Newkirk, R. L. (1973). A comparison of learner control and machine control strategies for computer-assisted instruction. Programmed Learning and Educational Technology, 10, 82-91.

Perlmuter, L. C., & Monty, R. A. (1977). The importance of perceived control: Fact or fantasy? American Scientist, 65, 759-765.

Ross, S. M., & Morrison, G. R. (1989). In search of a happy medium in instructional technology research: Issues concerning external validity, media replications, and learner control. Educational Technology, Research & Development, 37(1), 19-33.

Schloss, P. J., Wisniewski, L. A., & Cartwright, G. P. (1988). The differential effect of learner control and feedback in college student's performance on CAI modules. Journal of Educational Computing Research, 4, 141-150.

Steinberg, E. R., Baskin, A. B., & Hofer, E. (1986). Organizational/memory tools: A technique for improving problem solving skills. Journal of Educational Computing Research, 2, 169-187.

Title:

Motivational Strategies in Computer-Based Instruction: Some Lessons from Theories and Models of Motivation

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Abstract

This paper proposes strategies of motivation in CBI derived from motivational foundations of cognitive, affective and social learning theories. The assumption made here is that motivation and achievement interact in ways that warrant a "holistic" examination of strategies incorporated into CBI. Thus motivation in CBI is not solely a function of affect- it can be strengthened by cognitive and social motivational influences. In this holistic motivational framework, CBI must serve to improve learners' expectations of success, enhance feelings of self-efficacy, increase perception of control and help learners make positive effort, ability and strategy attributions. The role of theories and models of motivation and their relevance to CBI is explored, and ways in which computers are amenable to the incorporation of strategies of motivation are explicated.

Motivational strategies in computer-based instruction: Some lessons from theories and models of motivation

Why do children enjoy computers? Why do they choose to return frequently and voluntarily to computer-based tasks? To persist with problem-solving or drills until they have achieved mastery? To demonstrate task engagement while working on the computer? Task persistence, perceived control, level of task engagement, cognitive effort expended, attitude towards learning, cognitive monitoring, expectancies of success, self-efficacy and self-worth have been traditionally studied under a component of learning labelled variously as achievement motivation, continuing intrinsic motivation to learn, intrinsic motivation, need for achievement. In the classroom learning context, extensive theoretical and empirical work has revealed the complex nature of factors affecting intrinsic and extrinsic motivation to learn (Brophy, 1983). This research has contributed towards a variety of interventions with demonstrated empirical merit in improving achievement and motivation.

The intent of this paper is to identify motivational strategies pertinent to a holistic approach to motivation in computer-based instruction. Relevant theories which encompass social, cognitive and affective foundations of motivation to learn are summarized, and implications arising from such theories in strengthening motivational aspects of CBI are explicated. An attempt is made to answer the following questions: What is the relationship between theories of motivation and computer-based motivational strategies? How can the unique attributes of the computer be used to create software incorporating empirically-based findings and guidelines from the theories of motivation? Finally, what functions must motivational aspects of CBI serve?

Computers and Motivation

At a time when there is nationwide concern about declining standardized scores, educators are advocating intelligent use of technology to make learning efficient, relevant, contemporary and interesting (Clark & Salomon, 1986; Winn, 1989). Motivational factors are an important mediator of performance, and are considered instrumental in the expenditure of cognitive effort (Bandura, 1977; Corno and Mandinach, 1983). What students perceive, encode and assimilate in classrooms, in social, affective and academic realms is a function of their motivational states (Thomas, 1980). These conclusions point towards the power of the environment in influencing motivation. Although learning from CBI is not the penacea to the complex issue of academic achievement, it can provide environments which are non-threatening, enjoyable and cognitively stimulating, while boosting achievement.

The unique attributes of computers which make them amenable to motivating instruction are specially apparent when compared to the manner in which classrooms are structured. Classrooms are characterized by a diversity of cognitive and affective aptitudes (Cronbach and Snow, 1977). In the absence of adequate time and attention by a single teacher managing an entire class, students are left on their own to manage the multitude of stimuli generated in the classroom. Learning in classrooms is social and open to evaluation by others (Ames & Ames, 1984). Without appropriate intervention, students may develop stable negative attributions which impinge on performance. Teacher expectations of students also serve as a self-fulfilling prophecies in student performance and behavior, affecting students' self-concept, effort expenditure and hence achievement motivation (Brophy, 1985; Ecles and Midgeley, 1989).

Well-designed computer-based instruction offers an environment which can offset some of these negative influences. By virtue of representing modern technological media, computers have an appeal that evokes curiosity (Brown, 1986). Students approach computers with a positive initial attitude, making them effective attention gaining devices (for eg., Hativa, 1988). In a meta-analysis of 51 CAI studies, Kulik, Bangert and Williams (1983) found that CAI improved attitudes toward coursework and the computer; the authors surmise that the decreased time in completing CAI assignments may be attributed to motivational influences of the computer. When asked to identify and rate what they liked about CBI and classroom instruction, sixth-grade students rated motivational attributes of computers higher than classrooms (Perez & White, 1985). In the same study, students identified content and computer related (motivational) aspects of CBI, whereas only content related features were identified for classroom instruction. Weisz and Cameron (1989) provide evidence that computers are liked because of the control they offer. Robertson, Ladewig, Strickland and Boschung (1987) found that using supplementary microcomputer instruction yielded significantly higher global self-esteem ratings, leading the authors to conclude that increased achievement which resulted from the use of CAI may have contributed to this increment.

Among the most appealing attributes of computers is their ability to individualize instruction and make it interactive; it is possible to engage learners longer and more meaningfully with individualized interaction (Jonassen, 1984). The cognitive motivational effects of CBI can be observed simultaneously in this adaptive framework: instruction can be so designed that students experience a feeling of success, as reflected in their performance, and develop positive expectancies of success. CBI gives students greater opportunities of choice than a traditional classroom. Immediate, consistent and non-judgemental feedback, an asset in learning from a cognitive viewpoint influences significant determinants of achievement behavior such as self-efficacy and expectancies of success (Hannafin & Dalton, 1984). Because computers are viewed as being fairer than teachers, students with a low self-image in class feel less vulnerable to social comparisons while working with computers. The benefits of immediate feedback in CBI, although seemingly obvious by now, should not be underestimated: it enhances perception of control, and maintains arousal. Finally, it allows students to work at their own pace, reducing the anxiety resulting from speeded learning and tests.

Investigations on computer-based motivational strategies (eg., Malone, 1981) have attempted to isolate variables which contribute to making learning interesting and fun. The focus of this line of research has been an in-depth analysis of computer games to unravel the mystery of sustained interest in learning from computers, resulting in a conceptual framework of motivation in computer-based instruction. However, this research has also culminated in questions regarding the validity of computer-based instructional games in all learning situations (Lepper & Chabay, 1985): should all instructional software be designed in the form of games to make CBI motivationally effective? Is interest or intrinsic motivation observed during games sustained over time? Is performance specific to the fantasy that students learned under? Further, Lepper and Hodell (1989) claim that some instructional games have more negative than positive features, and may provide inordinately high levels of excitement, which are detrimental to learning.

What then, are the determinants of motivation in tasks other than computer-based games? In the ensuing discussion, some such determinants of motivation are hypothesized based on empirical and theoretical support.

The cognitive, affective and social foundations of motivation

Two assumptions form the bases for a holistic approach to motivation in CBI. First, achievement and motivation are fostered through reciprocally interactive processes. Information is attended to, selected, transformed and assimilated with the learners' existing schema, causing shifts in the knowledge structures of the learner; this process, in turn affects values, beliefs, expectations for future tasks, and hence selective perception of incoming stimuli. Such interactions illuminate the significance of the environment- the structure of knowledge existing outside the learner. Salomon (1979) illustrates this elegantly in his theory of "reciprocal interactionism" in values, cognitions, expectations and beliefs between the medium and the learner.

Second, motivation is differentially influenced by cognitive, social and affective factors among learners with diverse learner characteristics. Several theories of motivation have examined affective sources of motivation; while valuable insight is provided by the role of individual affective variables (eg., persistence, locus of control, attributional style), these do not embody the holistic nature of academic learning, in which affective, cognitive and social forces reinforce eachother continually.

Cognitive foundations of motivation: An explicitly cognitive approach to motivation has been the focus several theorists (Corno, 1986; Corno & Rohrnkemper, 1989; Corno & Mandinach, 1983; Zimmerman & Pons, 1986). Corno & Mandinach (1983) believe that intrinsic motivation is a function of the level of cognitive engagement in a task. It is an outcome of self-regulated learning (SRL), which they define as "an effort put forth by students to deepen and manipulate associative network in content area, and to monitor and improve the deepening process" (p. 95). In this conceptual approach, SRL not only fosters increased learning, but increased motivation as well. The authors consider it the highest form of cognitive engagement, necessary for continued intellectual performance. In Corno and Mandinach's model, SRL processes consist of five component processes: alertness, selectivity, connecting, planning and monitoring. Alertness and monitoring are largely information acquisition processes, whereas the remaining three are transformation processes. Both these classes of information processing have a metacognitive component.

Zimmerman & Martinez-Pons (1988) state that self-regulated learners are "metacognitively, motivationally, and behaviorally active participants in their own learning process." (p. 284). They plan, organize, self-instruct, and self-evaluate at various stages during the acquisition process, while selecting, structuring, and even creating social and physical environments.

Corno (1986) has also focused on the metacognitive control components of self-regulated learning- cautioning, however, that metacognitive components are necessary but insufficient for self-regulated learning. From this viewpint, metacognitive efforts to monitor and control concentration and affect, in conjunction with the application of effective cognitive strategies serve the purpose of efficiency and effectiveness.

Social learning theory and achievement motivation: Social learnig theorists such as Bandura (1977; 1982) and Schunk (1984), maintain that the underlying facilitator of cognitive effort expended on learning a skill- the determinant of motivation, is self-efficacy. Self-efficacy is described as personal judgements about one's capability to organize and implement actions in specific situations that may contain novel, unpredictable and possibly stressful features." (Schunk, 1984, p. 48). In this theoretical framework, self-efficacy affects the choice of activity and the mental effort expended in understanding, monitoring and rehearsing. Further, low self-efficacy implies less eager participation in an activity, and vice-versa (Bandura, 1977). Factors affecting self-efficacy appraisal include purpose of instruction, perceived ability, task difficulty, effort, assistance, task outcomes, perceived similarity to models and persuader credibility (Schunk, 1989).

Another perspective on motivation originates from the concept of cooperative learning, extensively researched for its motivational and achievement benefits. For example, Johnson and Johnson (1985) view motivation as resulting from processes of cooperative learning, providing evidence that learners attribute group success to ability, which in turn promotes achievement. In their research cooperative learning has emerged as a strong predictor of academic success when compared to other forms of social interdependence such as competitive and cooperative environments.

From a social learning perspective then, improved achievement results in greater self-efficacy (Schunk, 1989), which is instrumental in expenditure of effort, providing an impetus to achievement.

Affect as a determinant of achievement motivation: Weiner (1979; 1989), proposes that individuals seek causes, or attributions of past success or failure, which in turn dictates their future expectancies of success and achievement behavior. These causal attributions fall into four categories: ability, task difficulty, effort and luck, and lie along three causal dimensions: internal-external, causal stability, (eg., stable-unstable), and controllability (controllable vs. uncontrollable events). Attributions and causal dimensions interact in different ways; for example, aptitude, effort and health are internal factors (within the volitional control of learner), whereas luck, task difficulty, help from others fall within the external dimension. Failure ascribed to internal factors (eg., lack of ability) produces lower expectancies of success. Similarly, ability is considered a stable dimension (versus effort), and prior outcomes ascribed to ability are more predictive of future performance than ascriptions to effort. Finally, whereas effort is under volitional control, ability is an uncontrollable dimension.

Another variable which has been universally acknowledged to affect motivation is perception of control (Schunk, 1984; Stipek & Weisz, 1981; Thomas 1980). Weisz and Cameron (1985) define it as the ability to cause an intended event. McCombs (1984) states that even if ability to succeed is present, achievement and motivation will be impaired without a perception of control. Perceived control increases judgements of self-efficacy or personal competence, implying positive effect on motivation and achievement.

The role of the self-system in intrinsic motivation: Recently, motivation has been construed as a function of cognitive and affective components, representing a holistic approach to learning. McCombs (1982; 1984), has emphasized the role of perceived self-efficacy and personal control in her proposed definition and perception of "continuing motivation to learn", which is defined as a "dynamic, internally mediated set of metacognitive, cognitive and affective processes (including expectations, attributions, beliefs about the self and the learning environment) that can influence a student's tendency to approach, engage in and expend effort in, and persist in learning tasks on a continuing, self-directed basis" (p. 200). A metacognitive self-awareness is an integral component of this model. McCombs recommends several interventions aimed at the self to optimize self-regulated learning. These consist of support to students which can focus on both internal self-system processes (eg., helping students change dysfunctional self-beliefs, values or motives via cognitive restructuring approaches), and on modifications to the external learning environments (eg., helping students acquire strategies for self-awareness, self-evaluation and self-monitoring).

Implications: Motivational Strategies for CBI

Implications for strategies promoting achievement through CBI include those derived from cognitive, affective and social learning theories. Cognitive support can be provided to the learner by embedded learning strategies (Jonnasen, 1988). Affective support is provided in through strategically designed effort, strategy and ability attributional feedback and by giving learners a perception of control. From a social learning perspective, feedback can be geared towards helping achieve self-efficacious behavior; cooperative learning, peer modeling and proximal goal-setting are suggested for boosting motivation through the enhancement of self-efficacy.

Cognitive approach to motivation in CBI

CBI can enable the development of self-regulated behaviors by providing adequate cognitive support through the incorporation of learning strategies into software design. Weinstein and Mayer (1986) define learning strategies as "behaviors and thoughts that a learner engages in during learning, and that are intended to influence the learner's encoding process" (p. 315). Jonassen (1988) states that currently, the capabilities of microcomputers are underutilized, resulting in shallow processing of content. He recommends a stronger cognitively-oriented approach, making learning more meaningful, generative and engaging during CBI. According to Jonassen (1988), generative learning strategies, that is, those that require learners to consciously relate new, incoming information to existing schema, can be effectively embedded in CBI lessons. Examples of such strategies are outlining, creating images, cognitive mapping, paraphrasing, summarizing. Thus criterial tasks (eg., practice items) which require studens to use these learning strategies actively must be incorporated. CBI can be instrumental in furthering achievement in this respect by replacing rote recall with deeper levels of processing, by forcing students to demonstrate strategic behavior before they can advance further in the lesson, and facilitating students' tasks by performing mechanical functions for them.

With their unique attributes, computers also allow facilitation of cognition through a modeling of cognitive functions (Clark & Salomon, 1986). For example, processing cues- eg., highlighting can help learners who cannot use these effectively (Jonassen & Hanuum, 1987). Gillingham (1988) proposes that in addition to presenting text in meaningful ways, CBI can monitor the reading of text in various ways to increase reader comprehension.

The role of another important determinant of achievement and motivation- "metacognition" is being increasingly recognized (eg., Armbruster, 1983; Baker & Brown, 1983; Flavell, 1979). Metacognition is described as the "knowledge and control the child has over his or her own thinking and learning activities." (Baker & Brown, 1983. p. 353). Use of cognitive and metacognitive strategies can strengthen the effectiveness of primary strategy use, promote performance and perception of control. Jonassen refers to these as "support strategies", or higher level executive control, and suggests that self-monitoring advisement or prompting on activities like planning, attending, encoding, reviewing, evaluating can be efficaciously incorporated in CBI.

Motivational CBI and the social learning perspective

Social learning theories such as Bandura (1977) and Schunk (1982; 1984) have empirically demonstrated the benefits of interventions designed to improve self-efficacy and hence performance among low-achievers. Among those which are relevant to CBI are effort attributional feedback related to past accomplishments, ability feedback, proximal goal-setting and peer modeling.

Research on cooperative learning approaches with CBI is beginning to identify variables critical for improved performance (Johnson, Johnson &Stanne, 1985; Hooper & Hannafin, 1988; Hooper, Ward, Hannafin and Clark, 1989; Webb, 1984) and fomenting positive attitudes (Dalton & Hannafin, 1984). Johnson & Johnson (1985) found that a combination of cooperative learning and computer-assisted instruction has an especially positive impact on female students' attitude towards computers. The role of the peer group as one of the most important external sources of support in computer-based instruction is emphasized by Brown (1986). In light of these findings, CBI should be designed to be adaptable for use with groups. Teachers must also explore benefits of peer modeling approaches (Bandura, 1982) to improve self-efficacy via cooperative learning. Software design should be flexible so that it includes goal structures (Johnson & Johnson, 1985), indices for group and individual success and accountability. Prompts on proximal goal-setting, and ability attributional feedback based on past successes can be powerful mediators in improving self-efficacy, leading to increased persistence in task performance (Schunk, 1989). The importance of performance feedback cannot be overemphasized: If it is frequent, contingent, informative and encouraging, it has primary impact on performance attributions and self-efficacy (Como & Rohrkemper, 1984).

Motivational strategies from the affective domain

Learner Control

Researchers of CBI believe that giving some kind of control to learners- the nature of which is still elusive- is desirable: It increases learners' feelings of perceived control and self-efficacy (Bandura, 1982; Stipek and Weisz, 1981), makes learning more relevant to the needs of learners, and improves attitudes (Weisz & Cameron, 1989). Lepper & Hodell (1989) claim that a lack of control can lead to learned helplessness. According to Merrill (1987), learners themselves arrive at self-determined instructional strategies which are optimum, when given an opportunity to exercise choice over them. In light of such benefits, it is unfortunate that students' autonomy and choice decline as they advance in grade level (Ecles & Midgeley, 1989). CBI can be instrumental in compensating for the structural inflexibility of school systems.

Which learners benefit from learner control in improving motivation is determined by relationships among ability, prior knowledge, task difficulty and nature of control (Snow, 1980; Steinberg, 1977). Interactions among these variables are the subject of current research on learner control. However, given their intrinsic flexibility, computers offer instructional designers a myriad of possibilities in presenting instructional content. Incorporation of strategies that allow learners to choose amount, sequence, pace, difficulty level of content can be achieved relatively easily. However, all strategies should be considered with attention to empirical findings to date (eg., Hannafin, 1984).

The "Bells and Whistles" of CBI

The instantaneous image conjured of motivation in the realm of computer-based instruction - complex, arresting animation, sounds, colorful graphics and text, although simplistic in nature, has piqued the curiosity of researchers who have studied these media attributes individually or collectively.

The embellishments that computers offer can be highly effective in promoting extrinsic motivation. Surber and Leeder (1988) required fourth and fifth graders to complete two versions of a lesson, one with graphic feedback, and the other with text feedback. Students in the graphic feedback condition returned to the drill more often than those in the text feedback condition. The advanced visual capabilities of computers- graphics and animation, permit the creation of effective, credible fantasies, an important variable identified in the design of computer games (Malone, 1981). Competition and challenge can be provided with a score and time counter, and by adaptively varying task difficulty (Jonassen and Hanuum, 1987). Recently, studies which compare the motivational and achievement influences exerted by an embellished versus a simple, non-embellished version of a lesson are beginning to show that the former not only attract children more often, but students also demonstrate increases in achievement scores over time (Lepper and Hodell, 1989). Thus the cumulative effects of entities such as color, graphics, and animation can be instructionally and motivationally powerful.

Effort, Ability and Strategy attributional feedback

The objective of attributional feedback is to facilitate learners' own perception of themselves as able, efficacious learners. It should help them see that effort and effective strategy use improve performance (Brophy, 1983), and hence foment a change in negative orientations towards temselves (McCombs, 1984). Research has demonstrated the benefits of effort attributional training in shifting learners' dysfunctional beliefs about their own ability (uncontrollable factor), towards attributions to effort and strategy use (Dweck, 1975). Clifford (1984) believes that strategy attributional feedback on failures can change them into problem-solving situations, diverting attention from the negative aspects of failure. Studies employing strategy training have yielded successful results: in one such study by Kurtz and Borkowski (1984), students who attributed success to effort were more strategic than those attributing outcomes to ability. Although no prescriptive rules exist for the design of effort versus ability attributional feedback, relationships between aptitudes, attributional style, age and sex are significant in determining the situation specific requirements of such feedback.

Researchers' efforts at changing students' negative perceptions about their own ability have focused on shifting such beliefs towards effort and strategy attributions, with the assumption that student behavior and attitudes are malleable (Brophy, 1985). Although such research has yielded positive results, perceptions obout one's ability (an uncontrollable, stable causal dimension) exert a more powerful influence in predicting performance, affect and behavior than effort, a controllable factor (Nicholls, 1979; Weiner, 1984). Thus both ability and effort warrant consideration in the design of feedback. Students like to perceive themselves as both able and hardworking (Covington & Omelich, 1979). Brophy (1983) states this succintly: "Students must be able to conclude that they have the ability to meet the demands made on them, if they make reasonable efforts to do so." (p. 202). To accomplish such perceptions the difficulty level of tasks should be easy to medium, with varying ability and effort attributions, depending on student ability, nature of task, demonstrated persistence.

Individual differences such as age appear to have a bearing on the conceptions of ability. Nicholls (1984) has demonstrated that different conceptions of ability should be used for different situations. For example, for adolescents the concept of ability is norm-referenced, whereas for young children it is self-referenced. Young children associate effort with ability, whereas adolescents attribute high abiltiy to a difficult task which requires less effort. Thus excessive effort attributional feedback may be counterproductive to adolescents' conception of ability, and beneficial for young children's beliefs.

Conclusion

Academic learning is intrinsically difficult, requiring concentration, self-regulated behaviors, persistence, cognitive effort and a positive, mastery-oriented outlook. In this context, the role of motivational influences in improving affect and achievement becomes even more critical. The motivational role of computers transcends beyond providing short-term interest and excitement for supplementary classroom tasks. As classroom and home use of computers increases, an innovative, creative role must be delegated to CBI in the development and maintenance of intrinsic motivation. From a cognitive viewpoint, CBI must provide meaningful, cognitively supportive instruction, geared towards improved performance; from an affective perspective, CBI should captivate the learner's attention, promote feelings and expectations of success, improve perception of control, increase positive attributions to effort and ability; and finally, from a social learning perspective, CBI must enhance self-efficacy and foster achievement and positive affect through social interactions, proximal goal-setting and attributional feedback. The concept of motivation in this framework is construed as that in which students show moderate levels of arousal; demonstrate metacognitive awareness and persistence using varying learning strategies (computer-provided or self-generated); make appropriate attributions to ability and effort; demonstrate perception of control, and learn through social interactions.

Bibliography

Armbruster, B.B. et al. (1983). The role of metacognition in reading to learn: A developmental perspective. Reading Education Report No. 40. ED 228 617

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191-215.

Bandura, A. (1982b). Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191-215.

Brophy, J. (1983). Conceptualizing student motivation. Educational Psychologist, 18, 200-215.

Brophy, J. (1985). Teacher's expectations, motives and goals for working with students. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education, Vol. 2. The Classroom Milieu. Academic Press: Orlando.

Brown, J. (1986). Some motivational issues in computer-based instruction. Educational Technology, 26(4), 27-29.

Clark, R. E. & Salomon, G. (1986). Media in teaching. In M. C. Wittrock (Ed.), Handbook of Research on Teaching, (3rd ed.). New York: McMillan.

Clifford, M. M. (1984). Thoughts on a theory of constructive failure. Educational Psychologist, 19, 108-120.

Como L. & Mandinach, E.B. (1983). The role of cognitive engagement in classroom learningand motivation. Educational Psychologist, 18, 88-108.

Como, L. & Rohrkemper, M. M. (1985). The intrinsic motivation to learn in classrooms. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education, Vol. 2. The Classroom Milieu. Academic Press: Orlando.

Como, L. (1986). The metacognitive control components of self-regulated learning. Contemporary Educational Psychology, 11, 333-346.

Covington, M. V. & Omelich, C. L. (1979). Effort: The double-edged sword in school achievement. Journal of Educational Psychology, 71(2), 169-182.

Cronbach, L.J. and Snow, R.E. (1977). Aptitudes and Instructional Methods. New York: Irvington.

Dalton, D. W. & Hannafin, M. J. (1984). The role of computer-assisted instruction in affecting learner self-esteem: A case study. Educational Technology, 24(12), 42-44.

Dweck, C. S. (1975). The role of expectations and attributions in the alleviation of learned helplessness. Journal of Personality and Social Psychology, 31, 674-685.

Eccles, J. S. & Midgley, C. (1989). Stage-environment fit: Developmentally appropriate classrooms for young adolescents. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education, Vol. 3. Goals and Cognitions. Academic Press: CA.

Flavell, J. H. (1979). Metacognition and cognitive monitoring American Psychologist, 34, 906-11.

Gillingham, M. G. (1988). Text in computer-based instruction: What the research says. Journal of Computer-based instruction, 15(1), 1-6.

Hannafin, M. J. (1984). Guidelines for using locus of instructional control in the design of comuter-assisted instruction. Journal of Instructional Development, 7, 6-10.

Hativa, N. (1989). Student conceptions of and attitudes toward, specific features of a CAI system. Journal of Computer-based Instruction, 16 (3), 81-89.

Hooper, S., Hannafin (1988). Cooperative CBI: The effects of heterogenous versus homogenous grouping on the learning of progressively complex concepts. Journal of Educational Computing Research, 4(4), 413-423.

Hooper, S., Ward, T., Hannafin, M. J. & Clark, H. T. (1989). The effects of aptitude composition on achievement during small group learning. Journal of Computer-Based Instruction, 16(3), 102-109.

Johnson D. W. & Johnson, R. T. (1985). Motivational processes in cooperative, competitive and individualistic learning situations. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education, Vol. 2. The Classroom Milieu. Academic Press: Orlando.

Johnson, D. W. & Johnson, R. G. (1985). Cooperative learning: One key to computer-assisted learning. The Computing Teacher, October, 11-15.

Johnson, D. W. & Johnson, R. G. (1986). Computer-assisted cooperative learning. Educational Technology, 12-18.

Johnson, R. T., Johnson, D. W. & Stanne, M. B. (1985). Comparison of computer-assisted cooperative, competitive, and individualistic learning. American Educational Research Journal, 23(3), 382-392.

Jonassen & Hanuum (1987). Research-based principles for designing computer software. Educational Technology, 27(12), 7-14.

Jonassen, D. H. (1985). Interactive lesson designs: A taxonomy. Educational Technology, 25(6), 7-17.

Jonassen, D. H. (1988). Learning strategies in courseware to facilitate deeper processing. In D. H. Jonassen (Ed.), Instructional Design for Microcomputer Courseware. New Jersey: Lawrence Erlbaum & Associates.

Kulik, Bangert & Williams (1983). Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 75(1), 19-26.

Kurtz, B. E. & Borkowski, J. G. (1984). Children's metacognition: Exploring relations among knowlede, process and motivational variables. Journal of Experimental Child Psychology, 37, 335-354.

Lepper, M. D. & Chabay, R. W. (1985). Intrinsic motivation and instruction: Conflicting views on the role of motivational processses computer-based instruction. Educational Psychologist, 20 (4), 217-230.

Lepper, M. R. & Hodell, M. (1989). Intrinsic motivation in the classroom. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education. Vol. 3. Goals and Cognitions. Academic Press: CA.

Lepper, M. R. (1985). Microcomputers in education: Motivational and social issues. American Psychologist, 40, 1-18.

Malone, T.W. (1981). Toward a theory of instrinsically motivating instruction. Cognitive Science, 4, 333-369.

McCombs, B. (1982). Learner satisfaction, motivation and performance: Capitalizing on strategies for positive self-control. NSPI Journal, 3-6.

McCombs, B. (1984). Processes and skills underlying intrinsic motivation to learn: Toward a definition of motivational skills training intervention. Educational Psychologist, 19(4), 199-218.

McCombs, B. (1986). The role of the self-system in self-regulated learning. Contemporary Educational Psychology, 11, 314-332.

Merrill, M. D. (1987). The new component design theory: Instructional design for courseware authoring. Instructional Science, 16, 19-34.

Nicholls, J. (1984). Conceptions of achievement and motivation. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education. Vol. 1. Student Motivation. Academic Press: Orlando.

Perez, E. C. & White, M. A. (1985). Student evaluation of motivational and learning attributes of microcomuter software. Journal of Computer-based Instruction, 12 (2), 39-43.

Robertson, Ladewig, Strickland & Boschung (1987). Enhancement of self-esteem through the use of computer-assisted instruction. Journal of Educational Research, May-June, 314-316.

Salomon, G. (1979). Interaction of media, cognition and learning. San Francisco: Jossey Bass.

Schunk, D. H. (1984). Self-efficacy perspective on achievement behavior. Educational Psychologist, 49, 848-857.

Schunk, D. H. (1989). Self-efficacy and cognitive skill learning. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education. Vol. 3. Goals and Cognitions. Academic Press: CA.

Snow, R. E. (1980). Aptitude, learner control and adaptive instruction, Educational Psychologist, 15, 151-58.

Steinberg, E. R. (1977). Review of student control in computer-assisted instruction, Journal of Computer-based Instruction, 3, 84-90.

Surber, J. R. & Leeder, J. (1988). The effect of graphic feedback on student motivation. Journal of Computer-based Instruction, 15(1), 14-17.

Thomas, J. W. & Rohwer, W. D. (1986). Academic studying: The role of learning strategies. Educational Psychologist, 21(1&2), 19-41.

Thomas, J. W. (1980). Agency and achievement: Self-management and self-regard. Review of Educational Research, 50(2), 213-240.

Webb, N. M. (1984). Learning in small groups: cognitive requirements and group processes. Journal of Educational Psychology, 23(9), 15-16.

Weiner, B. (1979). A theory of motivation for some classroom experiences. Journal of Educational Psychology, 71, 3-25.

Weiner, B. (1984). Principles for a theory of student motivation and their application within an attributional framework. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education, Vol. 1, Student Motivation. Academic Press: Orlando.

Weinstein, C. E. and Mayer, R. E. (1986). The teaching of learning strategies. In M.C. Wittrock (Ed.), Handbook of Research on Teaching, (3rd ed.). New York: McMillan.

Weisz, J. R. & Cameron, A. M. (1985). Individual differences in the students' sense of control. In Ames, C. & Ames, R. (Eds.). Research on Motivation in Education, Vol. 2, The Classroom Milieu. Academic Press: Orlando.

Winn, W. W. (1989). Toward a rationale and theoretical basis for educational technology. Educational Technology Research and Development, 37 (1), 47-56.

Zimmerman, B. J. (1986). Becoming a self-regulated learner: What are the key subprocesses? Contemporary Educational Psychology, 11, 307-313.

Title:

Distance Education and Learners' Individual Differences: An Examination of Different Instructional Procedures Designed to Accommodate the Learning Characteristics of Field-Dependent and Field-Independent Learners

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Distance education and learners' individual differences: An examination of different instructional procedures designed to accommodate the learning characteristics of field-dependent and field independent learners.

Learning is a complex process. In educational settings learning is the product of the interaction of teacher, student and instructional content and the environment (Keefe, 1987). Each of these complex elements has wide variation and that variation allows for accommodations to the teaching and learning process. Each of these aspects contributes something to the existing knowledge of learning and teaching. Even though each of these has been extensively investigated, much remains to be discovered about the learning process and how it can be optimized.

Due to the noncontiguous nature of distance education with its physical separation of teacher and students (Keegan, 1980) certain issues common to many educational contexts become exaggerated and therefore provide unique opportunities for examination (Calvert, 1988). This separation of teacher and students leads to concerns regarding the interpersonal relationships between the teacher and the students and the effect on cognitive achievement. Perhaps singling out one of these characteristics and examining it in a specific context, the distance education classroom, would have practical applications for learning and instructional theory for other areas of educational concern. Characteristic differences in cognition shape individual learning and performance and therefore have implications for teaching and learning.

It has been suggested by some educators that individual differences are a valid focal point for school reform and restructuring. In a learner-centered school setting there is apt to be attention given to individual learning styles (Keefe, 1987). Evidence can be found in recent research that the individual differences in learning style that the learner brings to any learning situation is worthy of examination (Ausburn & Ausburn, 1978; Burger, 1985; DeBasio, 1986; Halpin & Peterson, 1986; Harris, 1987, in Calvert, 1988; Moore & Bedient, 1986; Moore & Dwyer, 1991; Wieseman & Portis, 1990). Individual differences do make a difference!

Learning Styles

The concept of learning style is a basis for understanding the ways students learn (Keefe, 1987). Knowledge of cognitive styles, one aspect of total learning style, influences how students learn, how teachers teach, and how teachers and students interact (Kogan, 1971; Witkin, Moore, Goodenough, & Cox, 1977). Understanding student learning leads to consideration of the teaching and learning environment and that proceeds logically to educational improvement. The value of including learning styles in the instructional design of school curricula is that information about learning styles provides a more extensive profile of the learner beyond information that comes from knowledge of the student's IQ, aptitude test scores, and grade average (Messick, 1984; Keefe, 1987). In this manner educators can get a comprehensive assessment of the student and this is one of the important first steps in the instructional design process (Dick & Carey, 1985; Gagne, 1985).

Learning style refers to the way people absorb, process, and retain information (DeBello, 1990). Everyone has a preferred learning style and that style makes the same teaching method effective for some and ineffective for others (Dunn, Beaudry & Klavas, 1989). Learning styles are thought to be pervasive and consistent indicators of personal preferences. According to the National Association of Secondary School Principles learning styles are the "characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Keefe, 1987). Cognitive styles are information-processing habits; affective styles, motivationally-based processes; physiological styles, biologically-based responses. Learning styles have also been separated into environmental, social, emotional, and physical categories. (Dunn & Dunn, 1978).

Cognitive styles are information processing habits a learner uses to perceive, think, problem solve and remember (Messick, 1984). The cognitive style characterizes the person and continues to do so in a way that is stable over time (Manning, in Wapner & Demick, 1991). It was out of the individual-differences branch of cognitive-style research that the study of perception focused on what came to be known as cognitive styles or cognitive controls (Witkin & Goodenough, 1981). The term cognitive came to be used because the style is pervasive across both perceptual and intellectual activities.

A careful search of the literature reveals more than 20 dimensions of cognitive style to be found in experimental research. These can be further categorized into reception or concept formation styles. Some of the reception styles are: perceptual mode preferences, field independence/dependence, scanning, constricted vs. flexible control, tolerance for incongruity, automatization, conceptual vs. perceptual styles. The concept formation styles include: conceptual tempo, conceptualizing styles, categorizing, complexity vs. simplicity, and leveling vs. sharpening (Keefe, 1987).

The other two aspects of learning styles are the affective and physiological dimensions. The affective dimension includes these constructs: curiosity, persistence, anxiety, frustration, locus of control, risk-taking, self-efficacy, and self-actualization. Styles related to affective emotional aspects take into account an individual's motivation, self-confidence, persistence, need for structure and guidelines, and autonomy and self-directedness.

The third dimension, the physiological styles, include biologically based aspects such as: time-of-day, sex-related behavior, need for mobility, and environmental factors (Keefe, 1987). Included here are the visual, auditory, tactile and kinesthetic styles familiar to most people. Styles related to environmental elements refer to an individual's comfort level with the surroundings, such as the lighting level of the room, how much noise can be tolerated or is preferred, and ergonomic considerations like seating comfort.

Field Dependence

Of all the above mentioned cognitive styles one has many features and characteristics that make it especially suitable to be singled out for this study: field dependence/independence. There are several reasons for this suitability. The cognitive style of field dependence is probably the most researched cognitive style which gives a strong foundation upon which to draw conclusions. The great research activity in field dependence and independence can be attributed in part to its breadth and to its real, visible manifestations in everyday life. One of the outcomes of the research on field dependence over the years is the theoretical framework for recognizing the connectedness of psychological phenomena and functions previously not thought to be related (Witkin & Goodenough, 1981). The evolution and growth of the science of educational psychology is an ongoing, dynamic process. In this process new evidence emerges which is added to the present body of knowledge so that new principles are formed and new theories are offered. In this way phenomena which were observed many years ago take on fresh perspectives when they are linked to previously unrelated contexts. In addition to these reasons there exist effective and relatively easy methods to assess the presence of field dependence (Witkin & Goodenough, 1981). Field dependence is a measure of a cognitive style approach which brings an individual differences perspective to the experimental study of social interaction (Bertini, Pizzamiglio, & Wapner, 1986).

The concept of field dependence evolved from research during World War II which was searching for a way to determine pilots' aptitude for visual and spatial orientations. In those days the way field dependence was measured was to place the subject in a chair that was tilted relative to gravity in a darkened room. In front of the chair was a rectangular frame and a cylindrical rod. The frame was also reoriented so that it was out of alignment with gravity. The subject was to align the rod up to his perception of uprightness. Whether the subject could align the rod so that it was upright regardless of its relativity to the frame or whether the subject would align the rod with the frame which appeared to be upright is indicative of the subject's ability to orient physical objects. The field dependent person relies more on the visual environment to make a judgment as to the verticality of an object whereas the field independent person orients the rod to a vertical position regardless of the outward appearance of the rod and frame (Wapner, S. & Demick, J.1991; Witkin, H., Moore, C. A., Goodenough, D. R., & Cox, P.W.,1977).

Researchers noticed that subjects have a preferred way of integrating the many sources of information from the environment that contribute to cognitive decisions. Differences among subjects' preferences emerged. And they noticed that people tend to use that same frame of reference consistently to integrate information across a multitude of tasks (Witkin & Goodenough, 1981). This ability was later related to an ability to separate an item from an organized field which led to both the definition of field dependence and to other methods of measurement. Years of experimental research attempts have yielded the conclusion that these modes of establishing the upright depends on referral either to the body's position or to the external field. Hence the designation of field dependence for those who refer to the external visual field to determine upright and field independence for those who refer to their body position.

Field dependence is a capacity to overcome or analyze embedded contexts in perceptual functioning. Field dependent and field independent subjects differ in how they perceive the difference and not in how accurately they perceive. The intent of Witkin's original research was that field dependence and independence exist along a continuum. That is, there is no clear cut labelling; subjects only demonstrate more or less field dependence. At the field dependent end of the continuum subjects exhibit global behaviors. The less field dependent end of the continuum manifests behaviors that are specific and articulate.

Subjects who are classified as field dependent rely more on visual cues in order to make decisions about the environment. They are more socially oriented, attentive to interpersonal cues, have a preference to being physically close to others, express emotional openness in communication with others, rely more on information that is perceived to come from the world of objects and people around them. They depend on external referents to achieve solutions. They have greater interpersonal competencies; are more at home with people because they need other people to provide them with standards (in ambiguous situations) for judgment and action. They are likely to have professional lives involving the humanities, the social sciences, and the helping professions (Bertini, Pizzamiglio, & Wapner, 1986). They also tend to be influenced by authoritative opinion. Furthermore field dependent people may need detailed instructions from the teacher in problem-solving strategies and explicit explanations of performance outcomes (Witkin, 1977).

Subjects classified as field independent have a more abstract, impersonal orientation. They demonstrate greater physical and emotional distancing. They function with a greater degree of autonomy in inter-personal behaviors. They use internal referents to restructure the universe. They prefer relatively impersonal situations and maintain greater psychological and personal space from others (Greene, 1976). They are less likely to require detailed explanations and more likely to work with less guidance than are field dependent student. They show greater skills than the field dependent subjects in cognitive restructuring. They tend to choose vocations in the sciences and mathematics and favor isolation, intellectualization and projection over social integration of information.

In summary a personality theory has evolved from the observations and findings of the psychology of field dependence: field dependence/independence is a process variable describing ways of orienting and functioning and not the success in attaining goals; it describes pervasive dimensions of individual functioning; it is self-consistent in behavior and is predictable across situations; it is stable over time; one is not the absence of the other, instead it is bipolar with one end having distinct different competencies than the other; each pole has qualities that help people adapt under particular circumstances; it is value neutral.

Research Background of Field Dependence

The construct of field dependence is not related to some other constructs which at first seem to be related. For instance numerous studies have found field dependence is not related to the attitudinal construct of locus of control (Witkin, H. & Goodenough, G.1981). Field dependence is a process variable describing the individual's ability in information assimilating processes to separate self and non-self. Locus of control is an attitudinal or belief variable representing the individual's perception of the amount of personal or external control over life results. Field dependence has also been found to be unrelated to the cognitive styles of extraversion/introversion and impulsivity/reflexivity (Roodin, Broughton, & Vaught, 1974; Shapson, 1973; Tobacyk, Broughton, & Vaught, 1975, in Witkin & Goodenough, 1981, p. 48).

The theory asserts that the outcome of learning does not differ for the two types of learners but the procedures used in their learning may differ (Wapner & Demick, 1991). This theoretical position raises questions relevant to the educational implications of field dependence. These questions address the issues of how field dependence is related to academic achievement and how different instructional procedures accommodate the individual learning differences between the two types of learners. A common approach to adapting instructional strategies to the individual learner employs aptitude-treatment interaction (ATI) (Cronbach & Snow, 1969). In this method the teacher uses different strategies for each type of learner to see if there is an interaction between the learner's aptitude and the treatment. The instructional strategy is designed to complement the learner's preferred method of learning. The goal of ATI research is to identify which learners will learn best when taught one way, and which learners possessing an opposite trait may learn best in a different way. Such an investigation may reveal the importance of matching students' learning styles and instructional methods (Jacobs & Gedeon, 1982).

While previous research has yielded conflicting and inconclusive results, some important and substantive findings have emerged. Some studies have reported no differences in students' achievement for their cognitive style, the treatments they received or any interaction of the two (Canino & Cicchelli, 1988; Grippen & Ohmacht, 1977; MacNeil, 1980; Njus, Huges & Stout, 1981).

Other studies found that field independent students achieved higher scores than field dependent students no matter which treatment they received (Carrier, Davidson, Higson, & Peterson, 1984; Carrier, Joseph, Krey, & LaCroix, 1983; Frank, 1984; Halpin & Peterson, 1986; Kiewra & Frank, 1988; Provost, 1981; Smith & Standal, 1981; Strawitz, 1984a, 1984b; Thornell, 1977; Threadgill, 1979).

Some studies found significant interactions with field dependence and instructional treatments (Abraham, 1985; Douglass & Kahle, 1978; Kiewra & Frank, 1986; McLeod & Adams, 1979; McLeod, Carpenter, McCormack, & Skvaricius, 1978; Satterly & Telfer, 1979; Threadgill-Sowder & Sowder, 1982). In the study by Satterly & Telfer, (1979), the interaction reflected differences in achievement between cognitive style groups for one treatment or differences in achievement between treatments for one cognitive style group.

The study by Abraham (1985) is the only one which found a disordinal interaction that showed equal levels of achievement for the cognitive style groups receiving different instructional treatments. In this study foreign students learning to use participle phrases in either a deductive or example-instructional treatment achieved best when their cognitive style was matched with the instructional treatment best suited for that style. Other studies which claim disordinal interaction (Douglass & Kahle, 1978; McLeod & Adams, 1979; McLeod, Carpenter, McCormack, & Skvaricius, 1978; Threadgill-Sowder & Sowder, 1982) seem to show that when there was significant interaction the field independent students respond more to variations in instructional manipulations.

As shown from the above research results it is difficult to reach definitive conclusions. The instructional treatments in many of the studies varied the level of structure to correspond to the theoretical notion that field dependent students prefer and achieve best in a more structured learning environment and field independent students prefer and achieve best in a less structured learning environment. Results do not show this to be true in all cases. Often the effects of the cognitive style overcomes the instructional treatment and one cognitive style performs best regardless of the instructional treatment. Much needed research may bring more conclusive results.

Distance Education Research

Research in distance education in the 60's and 70's was mainly concerned with management, administrative and global descriptive theory building (Coldeway, 1988; Holmberg, 1990; Moore, 1985). With the increased demand in educational needs for adult education and the addition of new communication technologies educators became interested in building and maintaining enrollments. Much of the research was aimed at the practical, organizational aspects of distance learning in the world. In the last two decades a new trend in distance learning research has appeared: the application of scientific research methods to attempts to investigate the commonalities of existing educational research with the emerging field of distance education research (Coldeway, 1988). Also, theorists are beginning to contribute to a theory of distance education (Moore, 1973 & 1977 in Holmberg, 1990). With this new emphasis the importance of methodologies of research emerges. In distance learning the instructional content is conveyed from teacher to student through some medium such as satellite, telephone lines, microwave, computer connections and regular mail. With the evolution of new technologies distance education has grown and changed from the early days of correspondence study that once identified distance learning. There are many more opportunities to design and use interactive strategies in the instructional curriculum of distance education than there once was. Since modern distance education is a departure from the norm as far as educational contexts go, it offers an opportunity to apply research questions to a different environment. In this way the body of knowledge can be expanded by including a nontraditional context in the research literature.

Characteristics of learners, such as the need for interpersonal contact, the ability to work in an unstructured environment and satisfaction with the educational experience, characterize success in the distance education classroom and are learner attributes that are often studied in traditional classrooms (Riddle, 1992). Other important aspects of individual preferences worthy of investigation are: self-directedness and autonomy, need for a structured learning environment, and comfort with and preferences for working individually. Perhaps by singling these issues out and examining them in an environment where their presence is emphasized inferences can be made that generalize to other educational settings.

Design of the Study

A study will be conducted to determine if the learning style of field dependence/independence has any effect on the cognitive outcomes and attitudes of students in a distance education class. This research study is an examination of characteristics of learners and the kinds of instructional strategies used. This study will compare the instructional strategies of group and individual learning to see which strategy results in greater learning and which strategy students prefer and enjoy most when learning at a distance. Quantitative data will be gathered from two sources: a criterion referenced test of the instructional content presented during the study and from a Likert scale measuring attitudes, satisfaction, and preferences toward instructional strategies in a distance learning class. Both of these tests will be given before and after the study to assess any change in learning and attitude.

Subjects will be volunteer college undergraduate students. The pool of potential volunteers will be 235 students in four sections of an undergraduate class, (a section is the same class taught at different times). The subjects will be tested early in the semester before the study begins with three instruments. The first is the the Group Embedded Figures Test (GEFT) given to determine their level of field dependence. The (GEFT) is a paper pencil test composed of simple figures hidden within a field of complex figures. The timed test contains complex figures divided into two 5-minute testing sessions. One of eight simple forms is embedded in each complex figure. The subject is asked to trace only one simple form in pencil over the lines of the test booklet. The purpose of the (GEFT) is to assess an individual's perceptual differentiation. A person with greater differentiation typically scores above the median (9) and a person of lesser differentiation typically scores below the median (Witkin , 1971). The split-half reliability coefficient of the GEFT of 332 subjects with the Spearman-Brown correction was estimated at 0.89 (Burkhalter & Schaer, 1985).

The second test will be the criterion-referenced multiple choice pretest which is a test of their mastery of the content presented during the study. The test will be developed and then reviewed by subject matter experts, college professors who teach at a distance. The third test will be the Likert Scale which is a self-report instrument assessing their attitude and satisfaction about learning in groups or individually, being an active participant in their learning, their comfort level with being separated from the teacher, and their confidence in receiving the same instruction at a distance as they would have in a traditional class. This scale was developed and pilot tested by this researcher on 198 college students subjects and found to have a reliability coefficient of 0.75. (This test was developed using the expertise of an evaluation and measurement expert. This test was also reviewed by subject matter experts, college faculty members who have expertise in distance learning.)

At the beginning of the semester the students will be randomly assigned to one of two treatment groups by dividing the class role into two halves. The first treatment group will receive the instruction in small groups. A small group will consist of four students. The small group will function as autonomously as possible. They will be given a packet of instructions which will be designed to be self-explanatory. The teacher will operate as a facilitator only, answering questions as needed but encouraging the students to work together to reach the stated objectives. The second group will receive the same instructional materials and objectives as the small group treatment receives. This group will work on the materials individually. The teacher will facilitate and answer questions for students as they arise. The lesson plan, the objectives and the teacher will be the same for both groups. The difference will be that the students in the group will be able to work together to accomplish the objectives of the instructional module, and the students who work individually will not receive assistance from their fellow students. The instruction will take place over 2-3 class periods.

All of the instruction will be delivered at a distance by using two-way video and two-way audio media so that students and teacher can see and hear each other. At the end of the sessions all students will take the same test, that was given before the start of the study. In addition to the criterion-referenced test students will complete the Likert scale instrument again.

Research Questions

This study will examine the following research questions:

1. Field dependent students will show greater gains from the achievement pretest to the achievement posttest test in the group treatment than in the individual treatment.
2. Field independent students will show greater gains from the achievement pretest to the achievement posttest test in the individual treatment than in in the small group treatment.
3. Field dependent students report that they prefer group learning instruction and actually achieve better in the group learning treatment.
4. Field independent students report that they prefer individual learning and actually achieve better in the individual learning treatment.

This study will examine the following hypotheses:

There is no significant difference in the change scores of field dependent and field independent students from the criterion-referenced pretest to the criterion-referenced posttest.

There is no significant difference in the change scores of field dependent and field independent students on the pretest Likert scale assessing preferences for instructional strategy, need for interpersonal interaction and confidence with being in a distance learning class and the posttest Likert scale.

The differences in means for the four groups, field dependent in the small group treatment, field dependent in the individual treatment, field independent in the small group treatment, and field independent in the individual treatment, will be analyzed for any significant differences by using an analysis of variance. This research is ongoing and as such data is not available about the results of the study. Data from this research will be available to interested parties upon request.

Implications for Distance Education and Traditional Education

In distance education contexts, much research on individual difference factors needs to be done (Calvert, 1988; Coldeway, 1988). Some benefits of learning style research specifically for distance education include guiding the goals of the distance learning class, predicting the success of learners, allowing for selection of learners, designing courses more specifically for learner needs, having indicators as to the type and quantity of interaction between teacher and students, and offering learners opportunities to use strategies other than their preferred strategies to become more versatile in their learning behaviors (Ehrman, 1990; Thompson & Knox, 1987).

Knowledge of students' cognitive styles not only has relevance about individual learning but also about the nature of teacher-pupil interactions and of social behavior in the classroom (Messick, 1984). Educational research has shown that cognitive styles influence how students learn, how teachers teach, and how teachers and students interact (Witkin, Goodenough, & Cox, 1977). The knowledge of cognitive styles has value for education by identifying personal characteristics that may interact with instructional treatments that mediate learning, retention and transfer; as diagnostic tools for prescribing interventions; and by promoting the learner's flexibility (Messick, 1984). Results of research on individual differences have relevant applications to other learning settings so long as practitioners remain aware of the interdependence of individual differences, social and environmental factors, and learning outcomes.

Understanding the importance of learning styles to education leads to an expectation of the impact they have on the teaching/learning environment. Cognitive styles might provide an opportunity to tailor the mode of presentation to the characteristics of the student; improve the communication between teacher and student when teachers become aware of student's style variations; expand student thinking and learning strategies; extend educational goals to include not only knowledge acquisition but also student's manner of thinking (Messick, 1984). Scores on an achievement test don't give enough information about a student. More information is needed. Investigations into how students learn can provide even more information for the total picture of the teaching/learning environment.

References

Abraham, R. G. (1985). Field independence -dependence and the teaching of grammar. TESOL Quarterly, 20, 689-702.

Ausburn, L, & Ausburn, F. (1978). Cognitive styles: Some information and implication for instructional design. Educational Communications Technology Journal, 26, (4), 337-354.

Bertini, M., Pizzamiglio, L. & Wapner, S. (Eds.). (1986). Field dependence in psychological theory, research and application. New Jersey: Erlbaum.

Burkhalter, B. & Schaer, B. (1985). The effect of cognitive style and cognitive learning in a nontraditional educational setting. Educational Research Quarterly, 9(4). 12-18.

Calvert, J. (1988, August). Distance education research: The rocky courtship of scholarship and practice. Paper presented to the 14th World Conference on Distance Education. Oslo, Norway.

Canino, C., & Cicchelli, T. (1988). Cognitive styles, computerized treatments on mathematics achievement and reaction to treatments. Journal of Educational Computing Research, 4, 253-264.

Carrier, C., Davidson, G., Higson, V., & Williams, M. (1983). Selection of options by field independent and dependent children in a computer-based concept lesson. Journal of Computer Based Instructions, 11, 49-54.

Carrier, C., Joseph, M. R., Krey, C.L., & LaCroix, P. (1983). Supplied visuals and imagery instructions in field independent and field dependent children's recall. Educational Communication and Technology, 31, 153-160.

Coldeway, Dan. (1988). Methodological issues in distance educational research. The American Journal of Distance Education, 2(3), 45-54.

Cronbach, L. & Snow, R. (1969). Individual differences in learning ability as a function of instructional variables. Stanford: Stanford University, School of Education.

DeBasio, A. (1986). Problem solving in triads composed of varying numbers of field dependent and field-independent subjects. Journal of Personality and Social Psychology, 51, 423-430.

De Bello, T. (1990). Comparison of eleven major learning styles models: Variables, appropriate populations, validity of instrumentation, and the research behind them. Journal of Reading, Writing and Learning Disabilities International, 6(3). 203-222.

Dick, W. & Carey, L. (1985). The systematic design of instruction. (2nd. ed.). Illinois: Scott, Foresman and Company.

Douglass, C. B. & Kahle, J. B. (1978). The effects of instructional sequence and cognitive style on the achievement of high school biology students. Journal of Research in Science Teaching, 15, 407-412.

Dunn, R., Beaudry, J., & Klavas, A. (1989). Survey of research on learning styles. Educational Leadership, 46,(6), 50-58.

Dunn, R. & Dunn, K. (1978). Teaching students through their individual learning styles: A practical approach. Virginia: Reston Publishing Company.

Ehrman, M. (1990). Psychological factors and distance education. Journal of Distance Education, 4(1), 10-24.

Frank, B. M. (1984). Effect of field independence-dependence and study technique on learning from a lecture. American Educational Research Journal, 21, 669-678.

Gagne, R. M. (1985). The conditions of learning and theory of instruction. (4th Edition). New York: Holt, Rinehart & Winston.

Greene, L. R. (1976). Effects of field dependence on affective relations and compliance in dyadic interactions. Journal of Personality and Social Psychology, 34, 569-577.

Grippen, P. C. & Ohnmacht, F.W. (1977). Field dependence and dogmatism as mediators of performance on a programmed learning task with and without strong prompts. Journal of Experimental Education, 45, 13-15.

Halpin, G, & Peterson, H. (1986). Accommodating instruction to learners' field independence/dependence: A study of effects on achievement and attitudes. Perceptual and Motor Skills, 62, 967-974.

Holmberg, Borje. (1987). The development of distance education research. The American Journal of Distance Education, 1(3).

Jacobs, R. & Gedeon, D. (1982). The social behaviors of field dependent students in a personalized system of instruction course. International Journal of Instructional Media, 9(2), 145-156.

Keefe, J. (1987). Learning style: Theory and practice. Virginia: National Association of Secondary School Principles.

Keegan, D. (1980). On defining distance education. Distance Education, 1, 13-36.

Kiewra, K. A. & Frank, B. M. (1988). Encoding and external storage effects of personal lecture notes, skeletal notes, and detailed notes for field-dependent and field-independent learners. Journal of Educational Research, 81, 143-148.

Kogan, N. (1971). Educational implications of cognitive styles. In G.S. Lesser (Ed.), Psychology and Educational Practice. Glenview, Ill: Scott Foresman.

MacNeil, R.D. (1980). The relationship of cognitive style and instructional style to the learning performance of undergraduate students. Journal of Educational Research, 73, 354-359.

McCombs, B. L., & others. (1991). Learner-centered psychological principles: Guidelines for school redesign and reform. Unpublished manuscript.

McKenna, F. (1990). Learning implications of field dependence-independence: Cognitive style versus cognitive ability. Applied Cognitive Psychology, 4, 425-437.

McLeod, D. B. & Adams, V. M. (1979). Individual differences in cognitive style and discovery approaches to learning mathematics. Journal of Educational Research, 72, 317-320.

McLeod, D. B, Carpenter, T. P., McCormack, R. L., & Skvarcius, R. (1978). Cognitive style and mathematics learning: The interaction of field independence and instructional treatment in numberation systems. Journal for Research in Mathematics Education, 9,163-174.

Messick, S. (1984). The nature of cognitive styles: Problems and promise in educational practice. Educational Psychologist, 19(2), 59-74.

Messick, S. and Associates. (1976). Individuality in learning. San Francisco: Jossey-Bass.

Moore, M. G. (1985). Some observations on current research in distance education. Epistolodidaktika I, 35, 35-62.

Njus, H.P., Huges, R. P., & Stout, B.L., (1981). Cognitive style, teaching mode, and learning outcomes. Home Economics Research Journal, 9, 264-275.

Provost, G. L. (1981). Teaching strategies, modes of evaluation, and field dependence factor. Perceptual and Motor Skills, 52, 163-173.

Riddle, J. (1992, February). Individual differences and distance education: Varying instructional strategies to enhance cognitive and affective outcomes. A paper presented to the Annual Convention of the Association for Educational Communications and Technology. Washington, D. C.

Saterly, D. J. & Telfer, I. G. (1979). Cognitive style and advance organizers in learning and retention. British Journal of Educational Psychology, 49, 169-178.

Smith, E. R., & Standal, T. C. (1981). Learning styles and study techniques. Journal of Reading, 24, 599-602.

Strawitz, B. M. (1984a). Cognitive style and the acquisition and transfer of the ability to control variables. Journal of Research in Science Teaching, 21, 133-141.

Strawitz, B. M. (1984b). Cognitive style and the effects of two instructional treatments on the acquisition and transfer of the ability to control variables. Journal of Research in Science Teaching, 21, 833-841.

Thompson, G., & Knox, A. (1987), Designing for diversity: Are field-dependent learners less suited to distance education programs of instruction? Contemporary Educational Psychology 12, 17-29.

Thornell, J. G. (1977). Individual differences in cognitive style and the guidance variable in instruction. Journal of Experimental Education, 45, 9-12.

Threadgill, J. A. (1979). The relationship of field-independent/dependent cognitive style and two methods of instruction in mathematics learning. Journal for Research in Mathematics Education, 10, 324-331.

Threadgill-Sowder, J. & Sowder, L. (1982). Drawn versus verbal formats for mathematical story problems. Journal of Experimental Education, 54, 56-62.

Wapner, S. & Demick, J. (Eds.) (1991). Field dependence-independence: Cognitive style across the life span. New Jersey: Erlbaum.

Witkin, H. & Goodenough, G. (1981). Cognitive styles: Essence and origins. New York: International Universities Press, Inc.

Witkin, H., Moore, C. A., Goodenough, D. R., & Cox, P.W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 47, 1-64.

Title:

Effects of Animated Computer Simulations on Inductive Learning with Adults: A Preliminary Report

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Effects of Animated Computer Simulations on Inductive Learning with Adults: A Preliminary Report

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Two design features of the computer distinguish it from other educational media — greater display capabilities and the ability to provide continuous adaptive feedback. Relevant and sustained interactivity is central to instructional design (Gagné, 1985; Jonassen, 1988; Wager & Wager, 1985). The computer affords a wide range of interactive strategies at all levels of learning. Interactive learning strategies are usually grouped under the heading of practice. Practice that is designed to promote higher-level processing (Salisbury, 1988) often encourages students to use cognitive strategies such as informal hypothesis-testing to solve problems or resolve conceptual conflicts. Of the many available computer-based instruction (CBI) formats, simulations offer the most potential of exploiting both the display and interactive strengths of computers.

Simulations are constructed for two primary purposes: to study relationships in a model of a system (e.g. scientific simulations); and to teach users about these relationships (Duchastel, 1990-91). As an instructional tool, computer simulations allow users to have meaningful experiences within a system or domain through experimentation and discovery. Simulations can be designed to represent only a portion of the real world, thereby making an abstract situation more concrete. Users can generate and test hypotheses in a simulated environment by examining changes in the environment based on their input, but without the potentially undesirable consequences of reality. Thus, simulations help to enable students to learn specific problem solving strategies by receiving immediate feedback on decisions made while in the structured environment of the simulation (Gress, 1982). In instructional settings the student interacts with the simulation and observes the computer output as either verbal or visual feedback (Vernezky & Osin, 1991). Feedback can also be presented in real time, accelerated time, or decelerated time. This can be especially useful when the simulated event either occurs too fast (e.g. an internal combustion engine) or too slow (e,g, deforestation) in real life for the feedback to have any meaning.

Computer-based microworlds, which simulate information and relationships of complex systems in areas such as mathematics, science, and geography, also offer promise in the design of interactive learning environments (Collins, Adams, & Pew, 1978; diSessa, 1982; Papert, 1981; White, 1984; Montague, 1988). Microworlds, a concept derived from constructivism, are small representations of content areas or domains (Forman & Pufall, 1988). Microworlds are often confused with simulations. Although microworlds and simulations can remain entirely distinct, the characteristics of the two can overlap or even be synonymous depending on their design and on how each is used in a learning interaction. A microworld is often defined as a representation of the simplest model of a domain that can be recognized by an expert and, most importantly, which also matches the user's abilities, interests, and experiences.

Simulations, on the other hand, are generally designed to mimic real life experiences, such as a flight simulator. When designed as microworlds, simulations allow learning contexts and situations to be created which extend beyond the walls of a classroom — students can try to survive a trip to the South Pole, save a beached whale, run a campaign for President of the United States, or explore the systems of the human body. Simulations, especially those with game-like features, offer the potential for intrinsically motivating activities (Malone, 1981; Rieber, 1991). For simplicity, we will use the term "simulation" throughout this paper to refer to learning environments which incorporate features of microworlds.

The instructional effectiveness of a simulation is determined by three major aspects of its design: the scenario, the underlying model, and the instructional overlay. The scenario recreates a real life situation and determines what happens and how it takes place. The model is usually a mathematical formula that reflects the causal relationships that govern the situation. The instructional overlay includes the instructional design features of a simulation and how they should be used to optimize instruction. Simulators also enhance the transfer of learning by teaching complex tasks in an environment that approximates the real world setting (Reigeluth & Schwartz, 1989). Simulations provide students with opportunities to study processes, procedures, and phenomena that either cannot be taught under any circumstances or cannot be easily taught using traditional methods (Hannafin & Peck, 1988). Simulations differ from interactive tutorials, which help students learn by providing information and using appropriate question-answer techniques. In a simulation the student learns by performing the activities to be learned in a context that is similar to the real world (Alessi & Trollip, 1985).

Simulations can perform many instructional functions. They are frequently used as follow-up practice strategies for higher-level learning during traditional instructional designs. This type of approach is based on a deductive learning model, where students are formally introduced to a concept or a principle, followed by practice. A deductive approach provides structure to guide a student during an exploration of the simulated environment in predetermined steps, thus allowing for directed practice. Recent studies have reported successful applications of structured simulations as practice activities in the teaching of physical science (Rieber, 1990a, Rieber, 1990b; Rieber, Boyce, & Assad, 1990). One of the most important components of these structured simulations has been the use of animation as visual feedback. Animation can provide a constant stream of visual feedback based on moment-to-moment student input.

In addition, simulations can also be used in inductive learning strategies. Inductive approaches to learning have students interact with instances of subject matter before generalities are introduced and explained. An inductive approach is based on letting students discover the structure of the subject matter on their own (Bruner, 1966; Slavin, 1988). The same simulation used as practice in a deductive approach can also give a student the opportunity to freely explore an environment and learn by discovery or through game-like contexts. Do students need the added structure of guided activities called for by deductive approaches, or can they learn by just being given the opportunity to interact freely with a rich model of a learning domain? There is a need to continue the research of animation-based interactive strategies on the computer beyond their use as traditional practice activities.

The purpose of this study was to investigate the effects of interactive learning strategies, specifically visually-based, real-time computer simulations, on inductive learning of adults in physical science.

SUBJECTS

The subjects consisted of 160 upperclass undergraduate students (juniors and seniors) who were enrolled in an introductory computer education class. Participation was voluntary with extra credit in the course provided as an additional incentive to participate.

MATERIALS

The CBI content of the tutorial and simulation activities involved the physics principles of Newtonian mechanics. The tutorial was divided into four parts. The first part reviewed fundamental background vocabulary and concepts, such as mass, weight, inertia, and force. This part also formally presented Newton's first law of motion. The second part introduced Newton's second law of motion and then described applications of Newton's first and second laws given equal forces in opposite directions in one-dimensional space. The third part extended the application of Newton's first and second laws to include the effects of unequal forces in one-dimensional space. The fourth part introduced and explained applications of these principles in two-dimensional space. All instruction was presented at an introductory level intended for novices. The lesson was designed to exclude as much formal mathematics as possible and instead concentrated on concept formation and application.

DEPENDENT MEASURES

Three data sources were studied: performance, as measured by student scores on a posttest; comprehension monitoring; and response confidence. The posttest consisted of 27 rule-using questions using a multiple-choice format (1 answer and 4 distractors). The posttest measured student performance on the four lesson objectives previously described above. KR-20 reliability of all 27 questions was .86.

At various points during the instructional treatment, students were prompted to answer the following question: "If you were given the posttest right now, what do you think your score would be?" Students answered from 0% to 90%, in multiples of 10%. These introspection data on students' perceived level of learning during the lesson were designed to be an informal assessment of their comprehension monitoring. For this analysis, comprehension monitoring is operationally defined as the students' answer to this question immediately before the administration of the posttest. Students were also asked this question before they began the lesson, in order to test whether or not the groups were similar in the perception of how much they already knew about the material. No significant differences were found among the groups at the start of the experiment, $F(5,154)=1.70$, $p>.1$, $MS_e=4.31$. On average, students felt they would get about 38% of the posttest questions correct if given the test immediately.

Response confidence during the posttest was also collected. Immediately after answering each question, students were asked to rate how confident they were in their answer on a Likert-type scale from 1 to 9 where 1 was "I guessed" and 9 was "I know I'm right."

PROCEDURES

All instruction and testing was administered by computer. Subjects were randomly assigned to one of the treatment groups as they reported to the computer lab. Once instructed to begin, subjects completed the computer lesson individually. The posttest was automatically administered to each student upon completion of the four lesson parts. Approximately 90 minutes were needed to complete the lessons in each experiment.

DESIGN

A 2 X 3 factorial design was used in this study. Two levels of Tutorial (Yes, No) were crossed with three levels of Simulation (Structured, Unstructured, None). The respective simulation activity was provided immediately after each of the four lesson parts in the tutorial. Deductive learning strategies were comprised of conditions which included the tutorial. When paired with the tutorial, each simulation condition acted as follow-up practice in the tradition of direct instructional methods. Inductive learning strategies were comprised of the two simulation conditions presented as the sole learning experience. The no simulation, no tutorial condition acted as a posttest-only control.

The structured simulation condition consisted of a series of four separate computer simulations in which students were given increasing levels of control over a simulated, free-floating object (called a "starship"). This activity is termed "structured" because each simulation presented a controlled number of new subskills to students. Each successive simulation incorporated the subskills from the preceding simulation.

The unstructured simulation condition consisted of an open-ended and unstructured simulation in which students assumed full control over the animated starship from the very beginning. The simulation was presented using a game-like context. Students were provided with the goal of "docking" their animated starship with a "space station" (represented by a circle on the screen). A scorekeeping feature was built into the game in order to provide an extra level of challenge as well as to help students see whether or not their skills were improving. Students were given a total of 10 trials with this activity to provide a similar level of exposure as that experienced by students in the structured simulation condition. Figures 1 and 2 illustrate examples of the structured and unstructured simulation activities.

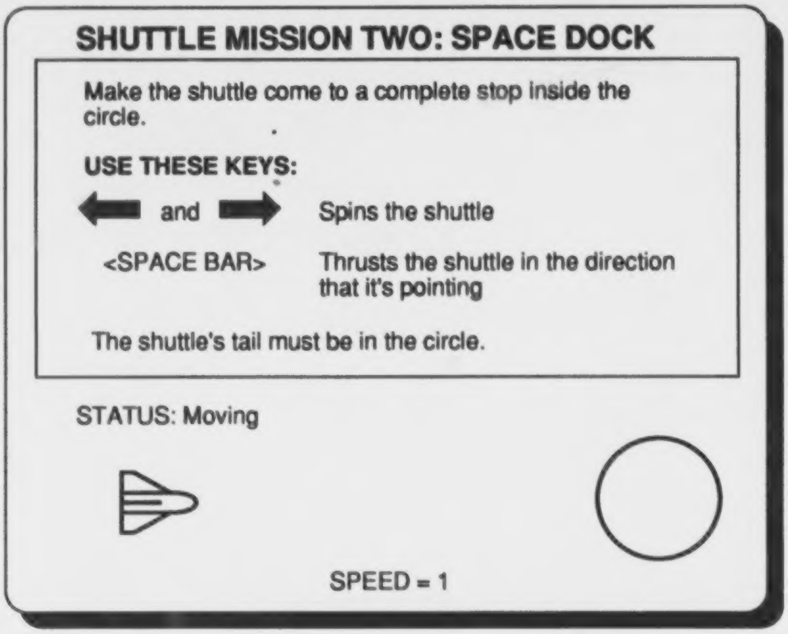
Statistical procedures included analysis of variance (ANOVA) on each of the dependent measures and Tukey's studentized range test for follow-up multiple-comparisons on means.

RESULTS AND DISCUSSION

A significant interaction was found between Tutorial and Simulation, $F(2,154)=7.13, p<.01, MS_e=279.89$, on posttest performance, as illustrated in Figure 3. Students in the Structured Simulation/No Tutorial condition (mean=74.5%) performed as well on the posttest as any of the three Tutorial groups (mean=83.0%). All of these four conditions performed significantly better than students in the control condition (No Tutorial/No Simulation) (mean=54.1%). Student scores in the Unstructured Simulation/No Tutorial condition (mean=67.6%) did not vary significantly from those of the control condition. These performance results support the hypothesis that adult students would be able to induce and apply relevant physical science rules given experiences with real-time computer simulations. However, the simulation was only effective in promoting inductive learning when it was structured so as to introduce a limited number of learning variables at a time. Learning was obviated when this structure was removed from the simulation and subjects were placed in a simple, yet open-ended simulation. It should be noted that the tutorial appeared to be an especially potent treatment variable and probably masked the effects of the simulation activities when they were paired with it.

A significant interaction was found between Tutorial and Simulation, $F(2,154)=4.99, p<.01, MS_e=3.15$, on comprehension monitoring, as illustrated in Figure 4. Follow-up analyses indicated two groups. Those who were given the tutorial or the structured simulation felt that they had learned significantly more than students given only the unstructured simulation or no instruction. Given only the unstructured simulation, therefore, students perceived they had not learned anything and felt totally unprepared for the posttest. However, students given only the *structured* simulation, but no tutorial, felt as though they had learned as much as students given the traditional tutorial.

The analysis of students' response confidence during the posttest also indicated a significant interaction between Tutorial and Simulation, $F(2,154)=4.53, p<.05, MS_e=2.77$, as shown in Figure 5. Follow-up analyses indicated three distinct groupings. Subjects in all three Tutorial conditions indicated the strongest level of confidence in their answers to posttest questions (mean=7.6). Next in order of response confidence were subjects in the Structured Simulation/No Tutorial condition (mean=6.1). Finally, subjects in both the Unstructured Simulation/No Tutorial condition and No Simulation/No Tutorial control condition constituted the third and lowest response confidence ratings group



SHUTTLE MISSION TWO: SPACE DOCK

Make the shuttle come to a complete stop inside the circle.

USE THESE KEYS:

⬅ and ➡ Spins the shuttle

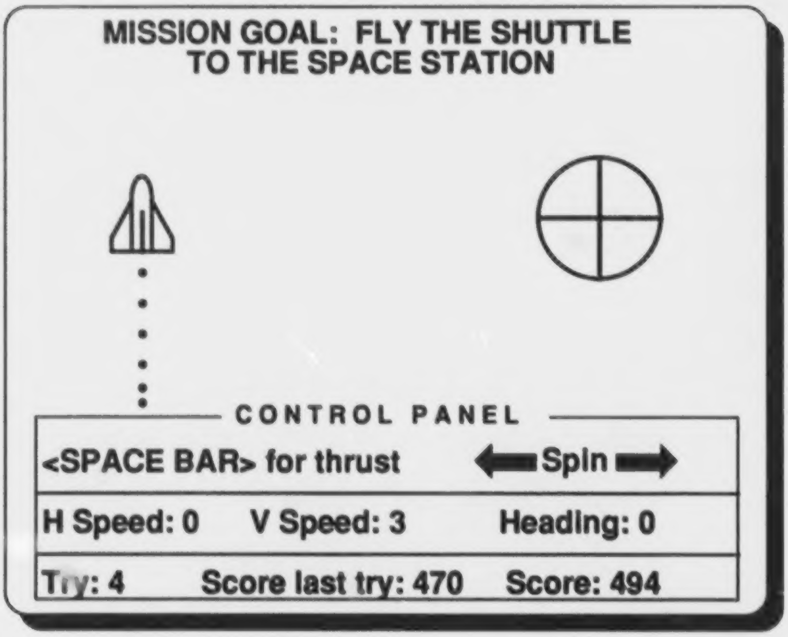
<SPACE BAR> Thrusts the shuttle in the direction that it's pointing

The shuttle's tail must be in the circle.

STATUS: Moving

SPEED = 1

FIGURE 1. *An example of a structured simulation activity.*



MISSION GOAL: FLY THE SHUTTLE TO THE SPACE STATION

CONTROL PANEL

<SPACE BAR> for thrust ⬅ Spin ➡

H Speed: 0 V Speed: 3 Heading: 0

Try: 4 Score last try: 470 Score: 494

FIGURE 2. *An example of an unstructured simulation activity.*

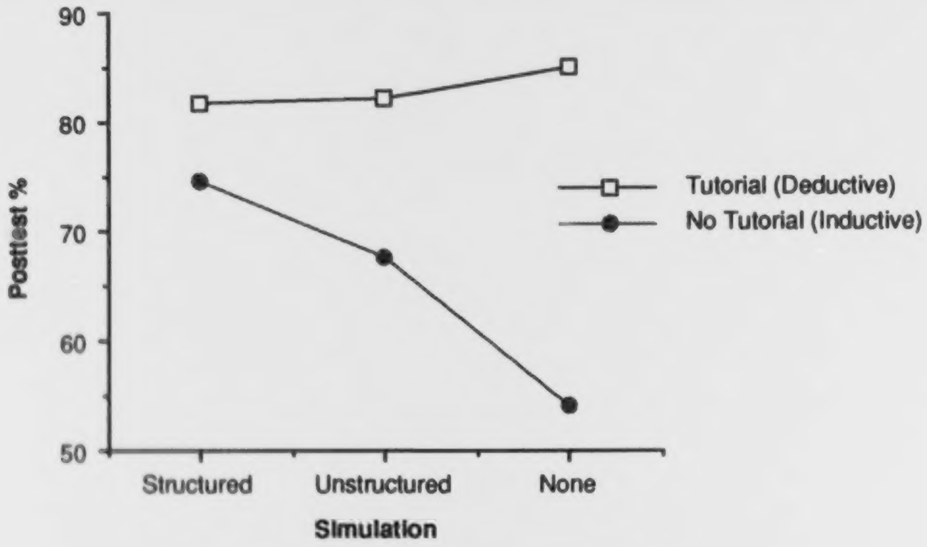


FIGURE 3. *Interaction between Tutorial and Simulation on the Performance Data*

(means=4.7 and 4.4, respectively). This pattern is similar to that of the comprehension monitoring data in that students given only the structured simulation felt more confident than students given only the unstructured simulation. However, students given only the structured simulation obviously lost confidence while answering the questions, as they were distinctively less confident than students given the tutorial.

So, while students in the Structured Simulation/No Tutorial condition performed similarly to students who received direct instruction via the tutorial, the former did not feel as confident in their answers to specific posttest questions as the latter. Hence, a lack of confidence may be among the consequences of providing adult subjects with experiential learning approaches, rather than direct instruction. Follow-up surveys with the students indicated that they felt very uncomfortable with the unstructured simulations — they had expected and wanted more structure. When adults are engaged in what they perceive to be a formal, or school-like, learning experience, they expect school-like learning environments to best aid their learning, and may actually resist the opportunity to learn by discovery. This point has been echoed by adult educators (Seaman & Fellenz, 1989).

A follow-up study has been conducted using children, although data have not, as yet, been analyzed. It is expected that children may be more receptive to learning from open-ended activities which offer little resemblance to "school-like" tasks.

REFERENCES

Alessi, S. M. & Trollip, S. R. (1985). *Computer -based instruction: Methods and development*. New Jersey:Prentice-Hall, Inc.

Apostolides, Z. (1987). Computer assisted instruction in biochemistry. *Biochemical Education, 15*(3), 129-133.

Atkinson, M., Burton, J.(1991). Measuring the effectiveness of a microcomputer simulation. *Journal of Computer-Based Instruction, 18*(2), 63-65.

Beck, C.(1985). The effects of pictorial and textual cues on learning intentional and incidental information. *International Journal of Instructional Media, 12*(4), 299-311.

Bruner, J. (1966). *Toward a theory of instruction*. New York: Norton.

Collins, A., Adams, M., & Pew, R. (1978). Effectiveness of an interactive map display in tutoring geography. *Journal of Educational Psychology, 70*(1), 1-7.

diSessa, A. (1982). Unlearning Aristotelian physics: A study of knowledge-based learning. *Cognitive Science, 6*(1), 37-75.

Duchastel, P. (1990-91). Instructional Strategies for simulation-based learning. *Journal of Educational Technology Systems. 19*(3), 265-275.

Forman, G., & Pufall, P. (Eds.). (1988). *Constructivism in the computer age*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Gagné, R. (1985). *The conditions of learning* (4th edition). New York: Holt, Rinehart, and Winston.

Gress, E.(1982). Computer simulations stimulate inductive thinking. *Twentieth Annual AEDS Convention Proceedings*. Washington D. C.:Association for Educational Data Systems, (Eric Document ED223239).

Jonassen, D. (1988). Integrating learning strategies into courseware to facilitate deeper processing. In D. Jonassen (Ed.), *Instructional designs for microcomputer courseware* (pp. 151-181). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hannafin, M.J., & Peck, K.L. (1988). *The design, development, and evaluation of instructional software*. New York: MacMillan.

Keller, J.M. (1979). Motivation and instructional design: A theoretical perspective. *Journal of Instructional Development*, 2(4),26-34.

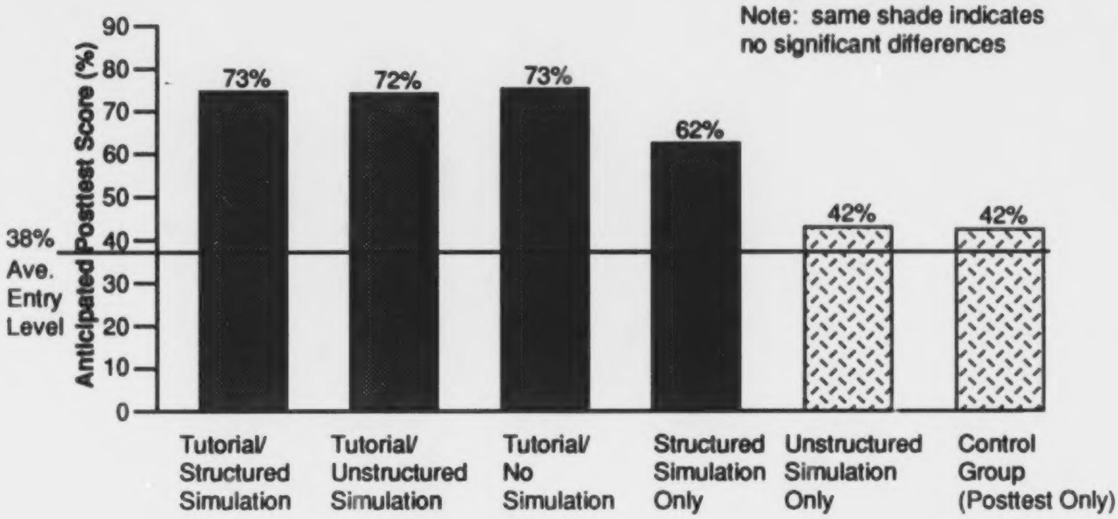


FIGURE 4. *Interaction between Tutorial and Simulation on comprehension monitoring data.*

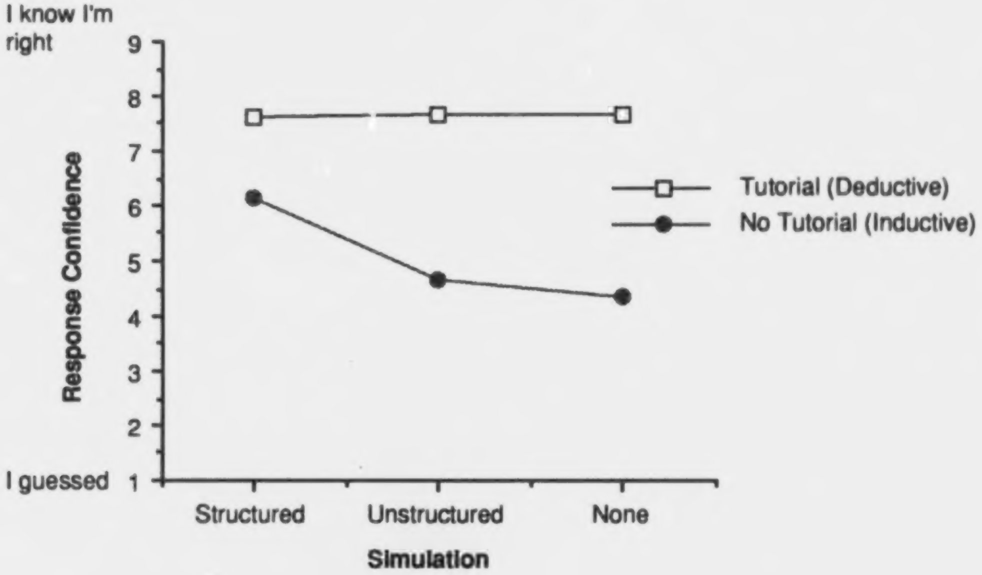


FIGURE 5. *Interaction between Tutorial and Simulation on the response confidence data.*

Keller, J.M. (1984). The use of the ARCS model of motivation in teacher training. In K. E. Shaw (ED), *Aspects of educational technology, Volume XVII: Staff development and career updating.* London: Kogan Page.

Malone, T. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 4*, 333-369.

Montague, W. (1988). Promoting cognitive processing and learning by designing the learning environment. In D. Jonassen (Ed.), *Instructional designs for microcomputer courseware* (pp. 125-149). Hillsdale, NJ: Lawrence Erlbaum Associates.

Orbach, E. (1979). Simulation games and motivation for learning. *Simulation and games. 10*(1), 3-39.

Papert, S. (1981). Computer-based microworlds as incubators for powerful ideas. In R. Taylor (Ed.), *The computer in the school: Tutor, tool, tutee* (pp. 203-210). New York, NY: Teacher's College Press.

Priestly, M. (1984). Computer simulations from the dungeons to the classroom. *Publishers Weekly*, 64-65.

Reigeluth,C., & Schwartz, E. (1989). An instructional theory for the design of computer-based simulations. *Journal of computer Based Instruction, 16*(1), 1-10.

Rieber, L. (1990a). Animation in computer-based instruction. *Educational Technology Research & Development, 38*(1), 77-86.

Rieber, L. (1990b). Using computer animated graphics in science instruction with children. *Journal of Educational Psychology*, 82(1), 135-140.

Rieber, L. (1991). Computer animation, incidental learning, and continuing motivation. *Journal of Educational Psychology, 83*(3), 318-328.

Rieber, L., Boyce, M., & Assad, C. (1990). The effects of computer animated elaboration strategies and practice on adult learning of physical science concepts. *Journal of Computer-Based Instruction*, 17(2), 46-52.

Salisbury, D. (1988). Effective drill and practice strategies. In D. Jonassen (Ed.), *Instructional designs for microcomputer courseware* (pp. 103-124). Hillsdale, NJ: Lawrence Erlbaum Associates.

Seaman, D.F., & Fellenz, R.A. (1989). *Effective strategies for teaching adults.* Columbus, Ohio: Merrill.

Shubik, M. (1989). Gaming: Theory and practice, past and future. *Simulation and games. 20*(2), 184-189.

Slavin, R. (1988). *Educational psychology: Theory into practice.* Englewood Cliffs, NJ: Prentice-Hall.

Stead, R. (1990). Problems with learning from computer-based simulations: a case study in economics. *British Journal of Educational Technology, 21*(2).

Strang, H., Landrum, M., Lynch, K. (1989). Talking with the computer: a simulation for training basic teaching skills. *Teaching and Teacher Education, 5*(2), 143-153

Vemezky, R. & Osin, L. (1991). *The intelligent design of computer-assisted instruction.* New York & London: Longman Publishing Group.

Versluis, E. (1984). Computer simulations and the far reaches of computer-assisted instruction. *Computers and the Humanities, 18*, 225-231.

Wager, W., & Wager, S. (1985). Presenting questions, processing responses, and providing feedback in CAI. *Journal of Instructional Development, 8*(4), 2-8.

White, B. (1984). Designing computer games to help physics students understand Newton's laws of motion. *Cognition and Instruction, 1*. 69-108.

Title:

Helping Faculty Develop Teaching Skills Through Workshops

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I. Introduction

The teaching skills workshops were originally developed in 1980 to train graduate assistants to teach college classes. Since then they have evolved into workshops that are being used by the faculty — instructors through full professors — to improve their teaching. The workshops have been successfully modified for use with different audiences and under varying time constraints. To date, over 800 faculty members have completed our workshops. As a consequence of these workshops, CIS is involved every semester in helping faculty to improve their classes.

II. Description of the Workshops

The workshops are a series of 10 90-minute sessions which are open to all faculty, graduate instructors, and staff. The individual sessions are:

1. **Student-Teacher Relationships** — This workshop describes the most common student complaints about instructors and suggests ways that instructors can improve their relationships with students. Student services at Purdue are discussed and directions for referring students with personal or academic problems are included.

2. **University Policies and Procedures Related to Teaching** — Purdue policies and regulations concerning instruction are discussed as outlined in the **Academic Procedures Manual**, the **Faculty and Staff Handbook**, and **University Regulations: A Reference Book for Students, Staff, and Faculty**. The procedures for appealing grades at Purdue are also discussed.

3. **Designing Instruction** — The importance of having consistent learning objectives, instructional activities, and evaluation procedures is discussed. Practice is provided in developing objectives and evaluating them using a checklist. Various types of instructional activities are presented. Exercises provide practice in matching objectives, instructional activities, and evaluation.

4. **Lecturing Techniques** — This workshop considers the strengths and limitations of lecturing as a teaching method. Ways to structure a lecture and utilize basic public speaking techniques are discussed. Techniques and checklists for evaluating lectures are provided.

5. **Audio-Visual Techniques** — This workshop provides a brief overview of procedures for scheduling rooms and audio-visual equipment . Recommendations for using the most common types audio-visual equipment —
audio and public address systems, chalkboards, charts and graphics, computer-displayed materials,film, objects, overhead transparencies, slides, and videotapes — are given.

6. **Micro-Teaching Exercise** — The workshop provides each participant with the opportunity to prepare and present a five-minute segment of classroom instruction. The presentation will be videotaped and played back for the presenter and a small group of peers. During the playback, an evaluation form will be completed by all participants. Following this, strengths of the presentation and suggestions for improvement will be discussed.

7. **Discussion Techniques** — The workshop presents the advantages and disadvantages of group discussion as a method of teaching. It provides an organizational framework for effective discussions and suggestions for conducting discussions. It also outlines the responsibilities of discussion leaders and participants. conducting discussions. It also outlines the responsibilities of discussion leaders and participants.

8. **Developing Tests** — The purposes of and procedures for writing college tests are explained. The strengths and weaknesses of true/false, multiple choice, short answer, and essay tests are presented. Specific suggestions for writing each type of test item are discussed. Good and bad examples of test items are included.

9. **Scoring Tests and Assigning Grades** — Norm-referenced and criterion-referenced grading systems are compared and contrasted. The Center for Instructional Services' test scoring and analysis service is explained and its use for test improvement described. Several methods of assigning course grades are discussed. A variety of factors to be considered in assigning grades is presented, and the distinction between grading and evaluation is explained.

10. **Evaluation Instruction** — This workshop discusses techniques for assessing the effectiveness of instructional materials, the instructional environment, and the instructor. Techniques for peer, self, and informal student evaluation are explained. Two formal methods of student evaluation — Small Group Instructional Diagnosis (**SGID**) and the Purdue Instructor and Course Appraisal System (**CAFETERIA**) — are described.

These workshops are presented as a series during the fallsemester, before the spring semester, during the spring semester, before the summer session, and during the summer session. During the regular sessions (fall, spring, and summer), the sessions are presented twice a week during a five-week period. Before the spring and summer sessions, the workshops are presented in an intensive three-day format.

Each workshop is structured around a printed study guide distributed to the participants before the workshop. The workshops are designed to be highly interactive and to demonstrate ideas and techniques presented in the study guide. The optimum number of participants is 15. With less than 12 participants, the group does not provide enough interactivity. With more than 18, each member of the group does not get a chance to participate during each session. In order to keep the workshops moving and to provide a change of pace, two facilitators from the CIS staff are present at each workshop.

Assignments are used to provide a common experience base for participants and to generate materials which can be discussed during the workshops. There are three of these assignments:
1) participants are asked to submit questions about college teaching that they want answered,
2) to visit a class of another instructor, and 3) write objectives, instructional activities, and test items.

III. Advertising the Workshops

Four primary techniques are used to promote the workshops.

1. CIS Newsletter — This newsletter is distributed to all faculty and staff five times each year. It includes workshop dates in each issue and discusses the workshops once every fall in a special issue that provides an overview of CIS services.

2. University channel on the local TV cable system — Dates of workshops are listed in the coming events section. In addition, periodic descriptions of the workshops given in the news portion of the programming.

3. Direct mail — Announcements are sent to faculty and staff about every six months, depending upon length of the waiting list. These announcements are responsible for recruiting most of the workshop attendees.

4. Word of Mouth — This method has provided the best promotion possible, but it is very difficult to measure. Interested individuals frequently call and ask about the workshops. When asking about the workshops, they often tell us that colleagueshave told them about how helpful the workshops had been.

IV. Conducting the Workshops

Each workshop is structured around a printed study guide containing a set of objectives. The participants are expected to have read the study guides before the workshops. In order to ensure that all points are covered, a "continuity sheet" is prepared for use by the facilitators during each workshop (See **Figure 1**). These sheets are not rigid schedules, but rather flexible guidelines which allow the facilitators to respond to questions from participants and to spontaneous teaching opportunities. These sheets also provide a list of the items that are needed during the workshop. This has helped us to make sure that we have all the materials that we will need for a particular workshop.

The participants are encouraged to ask questions and to share teaching experiences with other participants. The workshops are designed to encourage interaction and dialogue among all participants and all facilitators. This dialogue has been very helpful in allowing the participants to share their experiences -- both good and bad — what worked and what did not. This helps to foster a climate of collegial sharing of experiences rather than lecturing by the master. It is during these dialogues that we begin to develop a relationship that later allows us to provide consulting services to some of the participants.

The workshop assignments involve participants in meaningful instructional activities. Participants write objectives, design instructional activities, construct test items, and share techniques for improving student-teacher interactions. The participants also observe another instructor in a teaching situation in the microteaching exercise. In this highly rated assignment, each participant prepares and presents a five-minute excerpt from a lesson to be videotaped. The videotape and the live presentation are critiqued (orally and in written form) by the other participants and the facilitators.

V. Evaluation of the Workshops

Five methods are used to evaluate the workshops.

1. Verbal comments by the participants — These informal comments, made during and after each workshop, provide valuable input for reviewing the individual sessions.

2. Session evaluation forms — These evaluation forms are completed by each participant at the end of each session, these forms (See **Figure 2**) ask for an overall reaction to the session as well as specific responses as to likes and dislikes about the session and suggestions for improvement. These forms have provided some of our best feedback.

3. Course and Instruction Evaluation — This form uses Likert-type items with statements about the instructors, the materials, the media, and the content. It serves two purposes: to improve the workshops and to demonstrate how this type of evaluation can be used in courses.

4. Small Group Instructional Diagnosis (**SGID**) — This session is conducted by a facilitator not involved with the workshop. The participants are broken into small groups and evaluate the overall workshop. The facilitator provides specific feedback to the workshop staff (See **Figure 3**).

5. Open-ended rating scale — The participants are required to pick which session they liked the best and which the least. They are then asked to tell us why they made their particular choices.

Evaluation is an on-going process with the first two methods used during and following each session, and the latter three techniques implemented near the end of the series of workshops. It should also be emphasized that as with any technique we use, we used this one to teach as well as to evaluate. Thus, we have the participants experience as well as use an evaluation technique in the expectation that they will want to use them later in their own teaching.

VI. Follow-up of the Workshops

As a result of the rapport established between the facilitators and the instructors, the participants often call upon the college teaching workshop staff for consultation following the workshops. The consulting may result in an answer to a simple question or a referral for a service. The facilitators often provide referrals to other individuals or services on campus. In other cases, the participants may need a major review and revision of their courses. The facilitators have provided instructional design assistance as requested.

The facilitators are available to visit individual classes of former CTW participants. Following the class, the facilitator sits down with the instructor to review strengths and weaknesses and to provide suggestions for improvement. The facilitators also review videotapes of former participants' classes at their request. Again, the facilitators review their findings with the instructors.

Workshop participants sometimes also request SGID's of their classes. One of the workshop facilitators conducts these SGID's, discusses the results with the instructor, and may suggest how the instructor can improve any problem areas uncovered by the SGID.

VII. Review of the Workshops

The series of workshops is reviewed by the staff three times each time they are offered. First, the staff reviews any weaknesses and suggests revisions the week before the workshops start. At this session, staff assignments are made for all 10 workshops.

Secondly, the staff meets once each week during the regular workshops to review the previous week's sessions and to plan any changes in the coming week's sessions.

Finally, after the workshops are completed, the staff reviews all the participant evaluations. The staff discusses any changes which might be made to improve individual sessions or the series as a whole. Generally, we try to work on the workshop that received the lowest rating. This way, we are constantly improving the workshops.

VIII. Modification of the Workshops

The individual workshops have been modified by the staff to meet specific needs and requests. If a participant raises a specific question related to the content of a particular session, the staff can modify that session to address that question.

The length of sessions can be increased or decreased to meet specific needs. They can be shortened to 50 minutes to fit the standard class period at Purdue. Generally we have found that the 90 minute length provides the best length time to allow all the participants to participate but keep the workshops moving along a an interesting pace. However, we will shorten them to fit the needs of a particular situation. Most often, we delete elements from a workshop to achieve the shorter time frame.

The staff has also reformatted and reshaped sessions for particular audiences. For example, sessions have been modified for specific departments or specific teaching strategies and to meet the needs of foreign-born teaching assistants. We have also modified the workshops for presentation to the trainers at a local corporation.

IX. Summary

The College Teaching Workshops are attended by faculty as well as graduate teaching assistants. In fact, the majority of the participants have been faculty. The workshops have resulted in a continuing stream of requests from former participants for different forms of consultation to help improve their teaching efficiency and effectiveness.

Requests continue for special workshops to help faculty and graduate teaching assistants in their teaching and professional presentations. These requests have often come from former workshop participants. Thus, the workshops have helped to generate an increasing interest in the improvement of teaching on the Purdue campus.

REFERENCES

Brown, G. and M. Atkins (1988). **Effective Teaching in Higher Education**. New York: Methuen.

Clark, D. J. (1982). "The History of SGID Development." **SGID Newsletter**, 1 (1), 2.

Coffman, S. J. (1991) "Improving Your Teaching Through Small Group Instructional Diagnoses." **College Teaching**, 39 (2), 80-82.

Katz, J. and M. Henry (1988). **Turning Professors into Teachers: A New Approach to Faculty Development and Student Learning**. New York: Macmillan Publishing Company.

McKeachie, W. J. (1986). **Teaching Tips: A Guidebook for the Beginning College Teacher, (8th ed)**. Lexington, MA: D. C. Heath and Company.

Stafford, C. and J. R. Russell (1989). "Improving Instructionalm Skills with College Teaching Workshops." **Educational Technology**, 30 (4), 51-54.

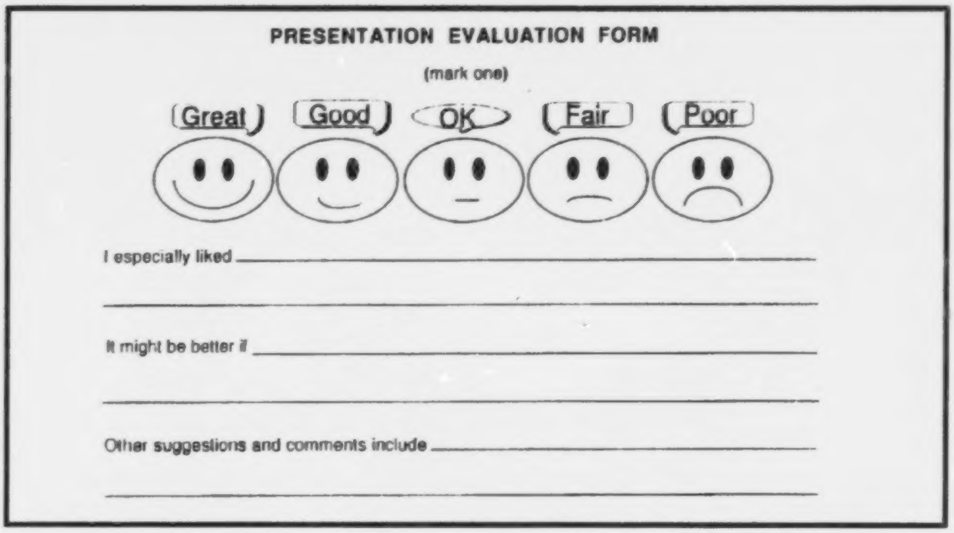
Figure 1: Continuity Sheet

A-V Techniques

1. write Agenda on board an go over objectives in study guide.
2. Show first half of **Project the Right Image** (were they knock the projector down).
   a) Questions on overhead: "What did Matthew sprocket fail to do?"
   ASIDE: pages 3-4 in study guide
3. Selection and Scheduling -- refer to study guide
4. Utilizing
   a) audio and public address
   b) chalkboard
   c) overhead
   d) slides
   e) film and video (**The Learning Edge**)
   f) object - Thubspot
5. Classrooms
6. Answer questions
7. Half-sheet evaluation

__ Indian map
__ template
__ damp cloth
__ **Project the Right Image**
__ colored chalk
__ ruler
__ felt tip markers (water soluble)
__ transparency set
__ extra study guides
__ next study guide (Discuss)
__ 1/2 sheet evaluations
__ microphone
__ **The Learning Edge**
__ slide set on slides with accompanying transparencies

Figure 2: Session Evaluation Form



PRESENTATION EVALUATION FORM

(mark one)

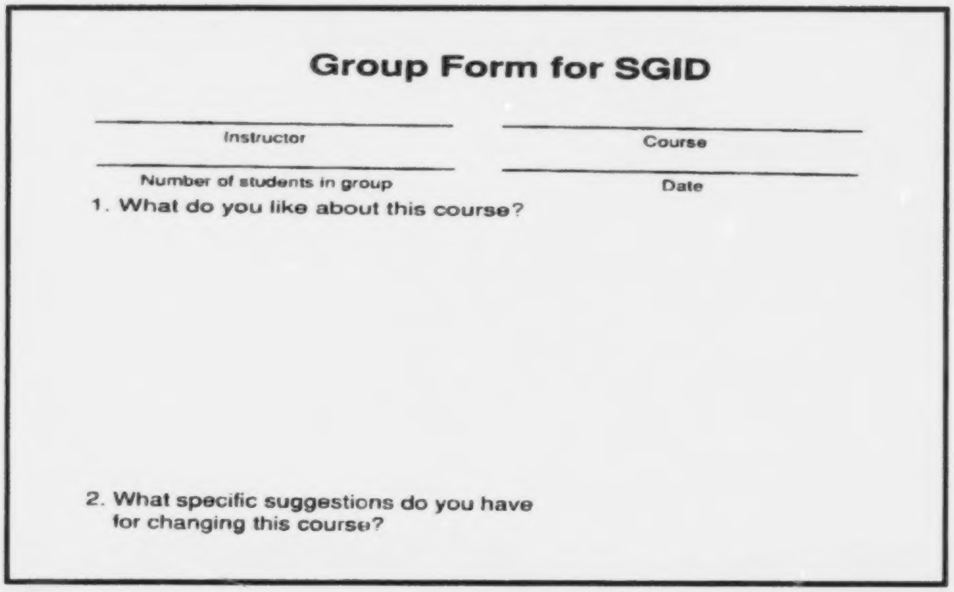
Great Good OK Fair Poor

I especially liked

It might be better if

Other suggestions and comments include

Figure 3: Small Group Instructional Diagnosis (SGID) Form



Group Form for SGID

Instructor

Course

Number of students in group

Date

1. What do you like about this course?

2. What specific suggestions do you have for changing this course?

Title:

Alternate Methods for Conducting Formative Evaluations of Interactive Instructional Technologies

Author:

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Alternate Methods for Conducting Formative Evaluations of Interactive Instructional Technologies

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Interactive technologies such as computer-based instruction, interactive video, hypertext systems, and the broad category of interactive multimedia systems are increasingly making an impact in educational and training settings. Many teachers, trainers, decision-makers, community members, and business and government leaders contend that these technologies will change the face of education and training (Ambron & Hooper, 1990, 1988; Interactive Multimedia Association; Lambert & Sallis, 1987; Schwartz, 1987; Schwier, 1987; U.S. Congress, OTA, 1988). Of concern is the claim by some that educational technologists are no longer the leaders in developing these technologies. Some are concerned that educational technologists are being left behind. One reason may be that technologists have neglected to prove the value of conducting evaluations of these technologies and thus cannot always show data to prove that systematically designing technological innovations for education makes a difference. One common feature of models for systematically designing instructional materials is that draft versions of these materials be tested with representative learners to ensure that the materials are effective (Andrews and Goodson, 1979) in the process called formative evaluation. Other terms, including developmental testing, pilot testing, field testing and validation, are occasionally used for this process. Most designers also draw a distinction between formative and summative evaluation. Generally, formative evaluation is conducted for the purpose of improving the instructional program through revision (Dick & Carey, 1990; Gagne, Briggs, & Wager, 1988; Morris &

Fitzgibbon, 1978). Summative evaluation is usually conducted to determine the overall value of a program, such as to make a "go" or "no go" decision about a completed program, often comparing it with other programs or approaches (Dick & Carey, 1990; Geis, 1987). The focus of this paper is on formative evaluation of interactive technologies.

While educational technologists acknowledge that we should be conducting more research and more research on formative evaluation specifically, the value of formative evaluation in enhancing the learning effectiveness of instruction has often been shown. One example is the recent meta-analysis conducted by Fuchs and Fuchs (1986). These researchers analyzed the results of 21 studies which investigated the effects of formative evaluation of materials developed for mildly handicapped students. They found that systematic formative evaluation significantly increased students' achievement when students used the resulting materials.

When to conduct formative evaluation is not always clear in instructional design models. Simplified graphics used to illustrate some models show formative evaluation being conducted using an almost-final draft of the instruction at the end of the design and development process. This may be appropriate for simple, print-based instruction, however most models show that formative evaluation is an ongoing process conducted throughout development. For example, Dick & Carey (1990) in their widely-used model recommend that formative evaluation include frequent reviews of materials, several 1:1 tryouts with learners who represent several segments of the target population, at least one small-group tryout, and a field test in the actual learning setting. On-going formative evaluation is particularly important in developing costly and labor-intensive interactive technology-based instruction. In fact, many small but critical design aspects of the interactive instruction, such as user-interface features like icons, menus, and navigational tools, are evaluated continuously in small segments as the project evolves.

While it is generally agreed that formative evaluation of instruction developed in any medium is critical, it is the premise of this paper that it is even more crucial when the instruction is to be delivered via interactive technologies, such as computers, interactive video or the various forms of interactive multimedia systems. For example, most design models for developing computer-based instruction (Gagne, Wager, & Rojas, 1981; Hannafin & Peck, 1988; Smith & Boyce, 1984) as well as interactive video for instruction (Kearsley & Frost, 1985; Savenye, 1990) call for conducting formative evaluations. There is a tendency, however, for evaluation to be neglected during development due to constraints of budget, personnel, and scheduling (Brenneman, 1989). This is, unfortunately, especially true in large-scale technology-based projects, in which costs are already high. Patterson and Bloch (1987) contend that formative evaluation is often not done during development of interactive instruction using computers. They mention that one reason for this may be that decision-makers in education and industry hold a negative attitude toward formative evaluation. These authors contend that educational technologists should recognize this fact, and help such constituents see the value of formative evaluation.

At the same time as formative evaluation procedures, and sometimes systematic instructional design itself, is sometimes assailed by developers of interactive instruction who have backgrounds other than instructional design, there are increased calls by funding sources and educators to use "qualitative" or "naturalistic" research methods in studying school and training processes and projects (Bosco, 1986; Clark, 1983). These methods are considered alternatives to more traditional approaches, such as using scores on paper-and-pencil achievement tests in experimental and quasi-experimental comparisons of programs. Sadly, at times producers of interactive educational materials have responded by collecting data on inappropriately small samples of learners, watching learners without first determining the evaluation questions, collecting too much data to effectively analyze later, and/or focusing on how well students like instructional programs, rather than on whether students learn through the programs.

Similar to the contentions about use of formative evaluation during development of interactive instruction, researchers have noted that there is little research being conducted on formative evaluation (Chinien, 1990; Geis, 1987; Patterson & Bloch, 1987). Thus it is likely that, just when we should be improving the ways we conduct formative evaluations, especially when developing interactive instruction, we are not conducting the research necessary to develop and test these improvements.

The purpose of this paper is to present methods for planning, conducting, and using the results of formative evaluations of interactive technology-based instruction. The focus is on practical considerations in making evaluation decisions, with an emphasis on alternate methods in formative evaluation.

Foundational Assumptions and Biases of This Paper

Lest the reader believe this author is contending that all these approaches to evaluation are new, we need only look at Markle´s 1989 "ancient history of formative evaluation" to remind ourselves that versions of these processes have been used by designers for many years, although often informally. Markle contends that even in the early, more "behavioralist", days of instructional design, developers listened to their learners, watched them carefully, and humbly incorporated what learners taught them into their drafts of instructional materials. Similarly, what recent authors, especially computer scientists, are calling testing in "software engineering (Chen & Shen, 1989; "prototype evaluation" (Smith & Wedman, 1988), "prototype testing", quality assurance" (McLean, 1989), or "quality control" (Darabi & Dempsey, 1989-90) is clearly formative evaluation by another name.

A controversy swirls in education and in our field regarding the relative value of "quantitative" and "qualitative" investigations. "Quantitative" usually means experimental or quasi-experimental research studies; in evaluation, these studies often compare one approach or technology with another. Some technologists have called for the abandonment of quantitative comparison studies (cf. Reeves, 1986), claiming they answer the wrong questions in limited ways.

Use of the term "qualitative" research is less clear. It usually refers to studies using anthropological methods such as interviews and observations to yield less numerical descriptive data. Unfortunately the resulting studies sometimes employ less than sound research methods. Such studies have given the term "qualitative research" a bad name in some circles, notably among those who are strong advocates of the sole use of quantitative methods.

It is the view of this author that when planning evaluations of interactive technologies the debate is not useful. Most practical educational developers have for many years used a blend of quantitative and qualitative methods in evaluation. "Quantitatively", there is, for example, a long tradition of using pretests and posttests to compare the performance of learners in a control group with those who have used a new educational technology program. "Qualitatively", evaluators have long collected attitude data using surveys, interviews and sometimes observations. Alternate research methods allow for collecting more types of qualitative data to answer the new questions which emerge in evaluating new technologies.

A more fruitful approach to the issue of which types of research methods to use is to select whatever methods are appropriate to answer the particular evaluation questions. Such an approach is in line with the recommendation of Clark (1983) that we reconsider our study of media. This approach is also similar to the ROPES guidelines developed by Hannafin and his associates (Hannafin & Rieber, 1989; Hooper & Hannafin, 1988) which blend the best of behavioralism and cognitivism in what they call "applied cognitivism". Finally, selecting methods based on questions supports Driscoll's (1991) suggestion that we select overall research paradigms based on the most urgent questions. Driscoll adds that instructional technology is a developing science in which "numerous paradigms may vie for acceptibility and dominance" (p. 310).

A final fundamental bias of this paper is that the most important question to ask during formative evaluation remains, "How well did the learners learn what we intended them to learn." This paper presents several types of data collection and analysis methods to answer important questions which emerge when interactive instructional technlogies are involved. Yet if we answer these questions and neglect whether students learn we will not know whether the technological innovation has any value.

Benefits of Considering Alternate Methods of Formative Evaluation

While, as noted earlier, the ideas are not strictly new, there are several reasons for a new and deeper look at formative evaluation when interactive technologies are involved. At one level developing instruction using technologies such as computers adds complexity to what can go wrong and what needs to be attended to, because there are hardware and software issues involved (Patterson & Bloch, 1987). For example, interactive systems are often multimedia systems, so formative evaluation questions often include how efffective graphics, animations, photographs, audio, text and video are in any lesson segment.

A second reason a new look at formative evaluation methods is warranted is that interactive technologies now allow developers to collect data about learners and learning that could not technologically be collected before. We can thus look at learning in new ways, and answer questions we may have wanted to answer before. For example, computer-based lessons can be programmed to record every keypress a learner makes. Developers can thus determine how many times a student attempts to answer a question, what choices they make, and what paths they follow through hypermedia-based knowledge bases. One danger, of course, is that developers can become "lost in data", collecting data without regard to evaluation questions and what to do with the data.

A third reason for study of formative evaluation methods is that with the recent renewed emphasis on qualitative research in education, have come increased numbers of good studies using alternate research methods. It is fortuitous that these methods, many borrowed from other fields, particularly anthropology and sociology, are being tested and results reported at a time when developers of interactive technologies are looking for new ways to measure how much our technologies help learners learn.

A final reason to expand our views of evaluation methods is to "push the envelope" of useful knowledge in our own field of educational technology, as many researchers and developers have called for. Reigeluth (1989) states that our field is now at a crossroads with considerable debate taking place regarding what we should study and how. Winn (1989) calls for researchers to conduct descriptive studies yielding more information about learning and instruction. In his often-cited article, Clark (1989) agrees with Winn, and states that researchers should conduct planned series of studies, selecting methods based on sound literature reviews. His recommendation that we conduct prescriptive studies to answer why instructional design methods work can especially be followed by evaluators using alternate research methods.

Results of Evaluations of the Overall Effectiveness of Interactive Technology-Based Instructional Programs

Computer-based Instruction

Recently several researchers have reported the results of meta-analyses of general evaluations of the effectiveness of various types of interactive technology-based programs. Evaluations of computer-based instruction (CBI) and interactive video will be presented. Although Ambrose (1991) has presented a literature review regarding the potential of hypermedia, there has not to date been a meta-analysis of research studies indicating the effects of these newer multimedia systems on learning. It is hoped that such meta-analyses may be conducted on these technologies in the future.

Several researchers have conducted meta-analyses to study the overall effects of CAI on student learning. For example, Kulik, Kulik and Cohen (1980) reviewed 59 evaluations of computer-based college teaching. They found that college students who learned using computer-based instruction (CBI) generally performed better on their exams than students who learned using traditional instruction, although the differences were not great. For example, they reported that the average exam score in CBI classes was 60.6 percent, while the average score in traditional classes was 57.6. While only eleven of the studies they reviewed reported attitude data, these researchers also reported that students who learned using CBI had a slightly more positive attitude toward learning using computers, and toward the subject matter. The most significant finding in this meta-analysis was that in the eight studies which investigated effects of CBI on instructional time, students learned more quickly using computers than in conventional classes. This finding of this study has often been cited as one powerful reason to use CBI in college classes.

Kulik and several other researchers (Kulik, Bangert, & Williams, 1983) also conducted a meta-analysis on the effects of computer-based teaching on learning of secondary school students. In this study they reviewed 51 evaluations that compared the final examination scores of students who had learned using CBI with scores of students who had learned using conventional methods. The results of this study indicated that learning using computers may be even more effective for younger students than for the older students described earlier. Again, students in CBI classes performed better. The average effect size in the CBI classes was .32 standard deviations higher than in conventional classes. Another way to describe this difference would be that students in the CBI classes performed at the 63rd percentile, while those in conventional classes performed at the 50th percentile.

In this meta-analysis, the researchers also investigated the effects of CBI on student attitudes. There was a small significantly positive effect of CBI on attitudes toward subject matter, computers and instruction. Only two of the studies they reviewed investigated instructional time, and in both students learned more quickly using computers. Thus, recent studies have indicated the effectiveness of CAI and CBI on student learning.

Interactive Video

Savenye (1990) presented findings of general reviews of evaluations of the effectiveness of interactive video as well as specific types of multimedia studies which have been conducted. To summarize her results, this researcher found that in the evaluations (Bosco, 1986; DeBloois, 1988; Slee, 1989) interactive video generally helped students learn better than they did through traditional instruction. She cautioned, however, as did Bosco, that when studies used statistical analyses differences tended to be smaller. In addition, this researcher reported that learners usually have positive attitudes towards learning through interactive technologies. As in the studies on CAI, researchers often found that learners learn faster using interactive video.

McNeil and Nelson (1991) conducted a meta-analysis of studies which evaluated cognitive achievement from interactive video instruction. These researchers used criteria including presence of learning measures, use of experimental or quasi-experimental design, and sound methodology to select 63 studies from an initial list of 367. One strength of their meta-analysis is that many studies had not been published, thus avoiding the bias toward significance of published studies noted by some authors.

Similar to Kulik, et al.'s results of meta-analyses on CBI, McNeil and Nelson found an overall positive effect size (.530, corrected for outliers) showing that interactive video is effective for instruction.

These researchers conducted several types of analyses in an admirable effort to isolate instructional design factors which contribute to the effect size. These analyses revealed that the effect sizes were homogenous, "but the selected independent variables did not explain the achievement effect," (p. 5). They did, however, note that there were some significant teacher effects indicating that interactive video was somewhat more effective when used in groups rather than individually. The authors remind us of the important role of the teacher in interactive instruction. In addition, similar to results noted by Hannafin (1985), as well as Steinberg (1989) for some types of learners, program control appeared to be more effective than learner control.

These researchers explained their results by noting that interactive video instruction consists of a complex set of interrelated factors. Reeves (1986) concurs. It will be a continuing challenge to researchers studying interactive instruction to isolate factors crucial to the success of innovative technologies.

Planning Formative Evaluations of Interactive Technology-Based Instruction

The following sections of this paper will present an overview of planning and conducting formative evaluations of interactive instructional programs. As noted earlier, it is assumed that formative evaluation is an on-going process, with activities conducted throughout all phases of design and development.

Begin Early

One key to conducting cost-effective and useful formative evaluations is to begin planning early, ideally from project inception. By beginning early, the goal of the formative evaluation is determined early as well. The subsequent processes and methods can be carefully selected and planned to collect the most important information. Stakeholders, managers, reviewers, instructors and learners can be identifed early, thereby limiting delays during development. Similarly, members of the development team who will assist in data collection can be identified, enlisted and briefed early. Early planning, in fact, can enable developers to collect data that would be impossible to collect if not identified early, because the systems (such as computer programs) to collect these data might not be developed when needed, or at all.

Determine Main Evaluation Goal

It is most useful for communication and efficiency purposes for one clear goal to be determined for the formative evaluation. Although developers may want to investigate many questions, the evaluation goal is usually some variation of how effective the interactive instruction is with learners and instructors. The 80/20 rule applies as much when conducting evaluations as it does in most other activities, that is, 80% of the benefits are derived from 20% of the effort. As development progresses keeping the evaluation goal in mind will yield maximum results and avoid team members wasting time on less important details. Maintaining a focus on one clear evaluation goal thus enables developers to keep a view of the forest, rather than getting lost in the trees.

Determine Major Evaluation Questions and Sub-questions

The major evaluation questions are derived from the evaluation goal. In formative evaluations of interactive instruction, as in evaluations of instruction using other media, there are typically, three major evaluation questions:

1) How well does the instruction help the students learn (an achievement question)?

2) How do the learners, instructors, and other users or constituents feel about the instruction (an attitude question)?

3) How is the instruction implemented (a "use" question)?

(Higgins & Sullivan, 1982; Morris & Fitzgibbons, 1979; Sullivan & Higgins, 1983).

To answer each question, evaluators and developers determine data to be collected, select data collection methods, develop instruments and procedures, and determine how data will be analyzed. One way to plan the evaluations to both keep the focus clear and make procedures most efficient is to develop a matrix to guide the evaluation and development team. Under each major evaluation question can be listed the related subquestions. Beside each question, as headings across the matrix would be "data sources" (instructors, learners, administrators, expert reviewers, etc.), "data collection methods" (measures of initial learning, measures of learning transfer, attitude surveys, interviews, observations, etc.), and "instruments" (pretests and posttests of achievement, instructor questionnaires, observational checklists, etc.) (cf. Savenye, 1986a).

Interactive technologies both allow for, and call for, different subquestions related to the three major types of evaluation questons. They also call for expanded views of what data can be collected and analyzed and how these data can be used. Developers and evaluators of interactive programs have a responsibility to add new methods to their evaluation "toolkits", to maintain an open view with regard to questions which need to be answered, as well as to report the results of their evaluations to benefit their colleagues who develop interactive technology-based instruction in all settings. The latter responsibility, in particular, has been noted by many authors (cf. Clark, 1989; Patterson & Bloch, 1987; Reigeluth, 1989; Winn, 1989).

Alternate methods of conducting evaluations are most useful, in fact may be critical, in answering the third major type of evaluation question - how is the interactive instruction implemented or used. Flexible, open views with regard to "what is really happening" when innovative approaches and technologies are used can result in finding that a critical component of instructor training, for example, had been left out of the initial design, or that learners are using the technology in ways developers never anticipated; in fact, they may be using it in better ways. This can yield what Newman (1989) calls answers to how the learning environment is affecting the instructional technology. Newman elucidates: "How a new piece of educational technology gets used in a particular environment cannot always be anticipated ahead of time. It can be argued that what the environment does with the technology provides critical information to guide design process" (p. 1). He adds, "It is seldom the case that the technology can be inserted into a classroom without changing other aspects of the environment," (p. 3), a fact often noted by instructional systems designers.

When such questions are not brought up and investigated, an instructional innovation can fail, as those who developed "programmed learning" in the sixties, or who have implemented educational technologies in other cultural settings without getting participant "buy-in" have learned. In other words, selecting evaluation methods with a critical eye toward the realities of what can be happening when we use new technologies is called for.

In addition, with the prospect of continued lack of support for "basic research" in educational technology, developers can contribute to the knowledge base in our field by conducting "applied research" in the form of rigorous high-quality formative evaluations and publishing their methods and results. Alternate research methods can be used carefully to answer "open questions" related to implementation of technology, such as how youngsters make decisions as they proceed through a simulation, or how teachers use an interactive videodisc program with whole classes. Results reported by an evaluator in one study can yield instructional design and implementation guidelines that developers can use and test. No less important to the continued improvement in our knowledge is that researchers can use results of "naturalistic methods" to formulate questions and isolate factors which can subsequently be investigated using experimental method, yielding causal interpretations.

The following section of this paper will present a discussion of multiple methods for conducting formative evaluations of interactive instruction, with particular attention to selecting appropriate methods.

Data Collection and Analysis Methods

While the goal of formative evaluation is to improve the learning effectiveness of the programs, the choice of methods for conducting evaluations is not clear-cut. As recommended by Jacob (1987) in her review of qualitative research traditions, methods should be chosen based on the research questions to be answered. In the case of evaluation, where resources are limited and the value of the process is not always clear to constituents, selecting methods should be driven by evaluation questions.

In addition, it is important that developers and evaluators contribute to our knowledge of effects of instructional design factors. As noted by many researchers (McNeil & Nelson, 1991; Reeves, 1986), instruction based on interactive technologies relies on many individual factors for its success, and each program is often unique in its approach, use of media, etc. The challenge to determine what factors make a difference in learning is great.

In the discussion below will be interwoven the utility of various alternate research methods with traditional methods. The methods will be presented with relation to major areas of evaluation types.

Instructional Design Reviews

Most instructional design models include the recommendation that draft versions of instructional materials be reviewed periodically during development. It is particularly important that aspects of interactive programs be reviewed at many stages during development. Geis (1987) recommends that materials might be reviewed by subject matter experts, instructional designers, technical designers such as graphic artists, instructors, individuals who have special knowledge of the target audience, influential community leaders, project sponsors, previous students and project editors. In a large-scale school science project, for example, initial objectives might be sent with brief descriptions of video and computer treatments for lesson segments to scientists, instructional designers and teachers using other materials developed by the organization. Subsequent reviews might elicit responses to depictions of computer menus, descriptions of branching options and simulation and game segments, as well as video storyboards.

While use of drafts of print materials, scripts and storyboards for reviews is traditional in formative evaluation reviews, it should be noted that computer programs, interactive video lessons, and interactive multimedia presentations are often too complex for many reviewers to evaluate in print form. Many evaluators, therefore, submit prototype versions of aspects of lessons, such as crucial menus, operational draft segments of simulations, or selected lessons to reviewers. Reviews are typically solicited early during formative evaluation activities to answer format, style, and content questions, and reviews continue on an on-going basis.

Determining Learning Achievement

Paper-based Tests. Traditional measures of achievement are still appropriate for use in determining how well learners perform after completing interactive lessons. Such measures are usually forms of paper-and-pencil tests. What is critical is that the test items match the learning objectives developed during design (Dick & Carey, 1990; Higgins & Rice, 1991; Sullivan & Higgins, 1983). Without such a match the test is often not useful, and, unfortunately this can often be the case in evaluating interactive programs in which developers let technical "bells and whistles" drive the design process. The decision to use paper-and-pencil tests is often made based on practical considerations, such as the fact that there may not be enough delivery systems for each student in a class, or that tests must be taken after students have left the training setting, or due to time limitations in accessing equipment. There is a danger, however, in using paper-and-pencil tests when learners received their practice in lessons through the computer or other technology. The "conditions" of the performance in the test may no longer match that of the objectives. Even a difference such as having computer graphics with text in practice activities with text only in the paper-based test can invalidate the test items. Technology-based tests to match the lesson objectives, format, and practice are thus somewhat preferable, unless the paper-and-pencil tests and technology-based practice are carefully matched.

Technology-based Tests. Computer-based achievement tests offer other advantages to paper-based tests. A test-item bank can be developed to allow administering multiple forms of the test. Data collection can be greatly simplified, in that computer programs can be written to transfer performance data directly to files for data analysis. (Of course, use of optically-scannable answer sheets with paper tests also increases efficiency). Adaptive tests might be developed that present specified items based on performance, and, once a student has begun to fail items based on a knowledge or skill hierarchy, for example, save testing time by not administering more items for advanced skills.

On-The-Job or Real-World Observations of Performance. A critical issue in evaluating learning is often how well students perform in their real-world settings. Although most instructional developers have traditionally recommended evaluating on-the-job performance, the efficiency of using less-realistic measures often ensures that paper-and-pencil or computer-based tests are used. Observations of learner performance in any work or life setting can, however, be conducted using methods adapted from ethnographic research.

Should evaluators decide to conduct observations, several decisions must be made. The team should determine who will conduct the observations, how the observers will be trained to ensure consistency, on what performances they will collect data, how observations will be recorded, how inter-observer reliability will be determined, how the data will be analyzed and how the results will be reported. For example, if the learned task is primarily procedural, it may be a simple matter to develop a checklist for recording how closely a student follows the required procedural steps in an assessment situation. In contrast, if the learned task was a more "fuzzy" type of skill, such as how to conduct an employment interview, the observational procedures, checklists, etc., would be more complex, and reliability of observations could be a trickier issue, due to subjectivity of what observers might be recording. Conducting observations of behaviors will be discussed further in a section concerned with evaluating implementation of interactive systems in real-world learning environments.

It might be noted that when it is not practical to observe student performance on the job or out of school, it may still be practical to conduct observations of students in "classroom" settings who are engaged in formal role-plays or simulations of the skills they learned through interactive instruction. The considerations described above would also be relevant in evaluating learning through such simulations.

Products/Portfolios. As noted by Linn, Baker and Dunbar (1991), there is increased concern among educators that traditional assessment methods shortchange evaluation of complex performance-based learning. In school settings, for example in programs to determine which students to include in gifted and talented programs, it is becoming common to include portfolios of student writing and other samples of the products of students' work. Interactive technology-based systems are often developed specifically to teach complex sets of behaviors and problem-solving skills through simulations. It is to be expected that instructional developers of interactive learning systems would collect products of student work to directly measure achievement of complex objectives.

For example, a student who learned to repair equipment by experiencing computer-and-videodisc simulations could be expected to demonstrate learning achievement by repairing an actual piece of malfunctioning machinery. The repaired equipment would thus be a product. Here again, as recommended by Dick and Carey (1990), Sullivan and Higgins (1983), and most other instructional developers, an evaluation checklist would be developed to determine mastery of the skill as demonstrated by the quality of the product.

Similarly, if a student learned to create an art piece by participating in a videodisc-based interactive lesson about a particular type of art, the evaluation would logically involve determining the quality of the student's creation, according to criteria established in the lesson.

One caution that applies in all types of evaluations of student products and portfolios relates to the alignment between practice and assessment activities. Developers and evaluators cannot expect learners to move directly from doing practice in a technology-based simulation to performing the skill in the real-world setting. As noted earlier, the conditions of the practice and assessment in this situation would not match. Developers would do well to ensure that learners engaged in learning using their instructional system receive some type of practice on the actual equipment or in the real-world setting, or producing the real product, before they are tested in the latter situations.

Time Measures. For some types of learning, mastery is measured by the quality or frequency of student performance within given time parameters. This would be the case, for example, for keyboarding skills in which mastery is demonstrated both by accuracy and speed. Interactive technology-based systems can easily record how quickly or frequently learners perform. In addition, it has often been noted that the "claim to fame" for technology is that it helps learners progress to mastery levels more quickly than through traditional instruction. Many evaluations of interactive instruction therefore include measures of time to mastery. It is likely that evaluations of evolving systems will continue to include collecting time data.

Self-Evaluation. In some instances, particularly in adult or recreational learning settings, collecting data regarding learners' perceptions of their own achievement of skills is desirable. Such data can be collected using straightforward questions on survey instruments, such as "How would you rate your skill in ________ now?" Such self-report data is often biased, however, and so it is usually more useful to collect data which directly measures student learning. However, at times, developers may also be concerned with learners' perceptions of their learning, perhaps for political reasons, and these may be useful depending on the evaluation questions.

Interviews. Although not typically used to collect achievement data, there are a few instances in which interviews might be useful. Interviews may be conducted to collect self-evaluation data. In addition, with very young students or those who are not literate interviews may really be oral tests conducted to measure learning achievement.

Occasionnally, especially in training settings, interviews are conducted with managers to determine how well they believe employees learned the skills practiced through interactive instruction, and how well managers believe employees are now performing in their jobs. Collecting these data sometimes has the side benefit of contributing to managers' "buy-in" of the interactive training, as they reflect on what their employees learned through the training.

Documentary Data. In some settings, evaluators of interactive technologies will secure access to data already existing in the organization. In educational settings these data might be end-of-course grades. For example, the final grades of college students' who completed a course delivered via interactive video might be compared with those of students who completed the course in a traditional manner. In schools districts, evaluators may secure access to student performance on yearly standardized tests. In both these cases, these data would be more relevant for whole courses which used interactive technology than for those courses which employed technology in a supplementary and limited manner.

In training settings, evaluators might review industrial documentary data regarding increased production, decreased loss due to error, decreased reports of health or safety violations, reduced customer complaints, increased efficiency, etc.

Issues Related to Transfer. A particularly sticky issue in education is how well learners can perform in real-world settings the skills they mastered in artificial settings such as classrooms. Many advocates of multimedia argue that interactive instructional programs can closely simulate the real-world, sometimes calling such systems learning environments. For example, one interactive video curriculum has been developed to train reserve soldiers to repair and maintain the M-1 tank (Savenye, 1986b). Yet in this project military trainers noted that troubleshooting a firing system malfunction based on video and audio displays, and then selecting a decision such as replacing a part from icons on a menu is not the same as actually performing these activities on a tank. While few evaluations have measured learning transfer to on-the-job or outside-school tasks, some studies have indicated learning through interactive media does help students learn to transfer their knowledge to other settings more quickly than learning through traditional instruction (DeBloois, 1988).

It will remain a responsibility of developers to use technology to build learning systems, especially simulations, that enhance learning transfer, and of evaluators to creatively measure such transfer.

Issues Related to Retention. Regardless of how learning is measured it is advisable to administer delayed versions of tests or other measures to determine how much learner retain of what they have learned. It is not difficult in on-going interactive curriculum materials to build in periodic tests which students might view as "reviews", but which developers could use to measure retention.

Answering Other Types of Learning Questions

Interactive technology-based instruction may be used in nontraditional educational settings, such as in museums and parks, or even for delivery of information, as opposed to instruction. In these cases the learning to be measured may be quite different from achievement of learning objectives and the evaluation questions, therefore, may differ.

An example of such a situation was presented by Hirumi, Allen and Savenye (1989). These authors discussed the development and evaluation of an interactive videodisc-based museum exhibit to introduce visitors to the plants and animals of the desert. In a museum setting visitors experience an exhibit in groups, with only one or two individuals actually making choices on the computer. Visitors spend little time with an exhibit, and are unlikely to be willing to take traditional tests. In this type of setting, if learning from the interactive exhibit is a concern, a limited number of nonthreatening learning achievement questions can be asked of samples of visitors in very brief interviews. If classes of children visit the museum it is often possible to ask them to complete short activities which they may perceive as fun, but which actually measure learning.

Technology-based learning environments may be developed with broader goals than to teach specific objectives. They may, for example, be based on an exploratory learning approach with the goal of enhancing student motivation to prepare them to participate in more structured learning activities later. Such exploratory systems may include a videodisc that shows students whatever aspects of a setting they may choose, for example selected parts of a town or archaeological site, or the flora and fauna of natural surroundings. These systems often are based on hypertext, and thus allow learners to branch in a network fashion from any bit of information in the database to any other. Evaluators investigating effects of such exploratory learning environments may, depending on the evaluation questions, collect computerized data on the pathways learners take through information, and what choices they make. If most learners bypass some parts of the information, for example, or always go through some parts, evaluators could conduct followup interviews to ask learners why they make the choices they do.

A technique of using read-think-aloud protocols could also be used (Smith & Wedman, 1988) to analyze learner tracking and choices. Using this technique, evaluators could ask learners to "talk through" their decisions as they go through a lesson. Evaluators could observe and listen as learners participate, or they could audiotape the learners and analyze the tapes later. In either case, the resulting verbal data must be coded and summarized to answer the evaluation questions. Techniques of protocol analysis (cf. Ericsson & Simon, 1984) should be determined and tested early in the evaluation process.

As described earlier, observations of actual or simulated performances may be called for, although in these nontraditional learning environments performance is not always as much a concern as is motivation.

In contrast to these nontraditional educational settings, in which performance is not always critical, business and industrial settings in which training is delivered on-line or on-demand, do hold learner performance to be of utmost concern. Yet these settings do not always allow for traditional testing. It is not difficult, however, to develop unobtrusive, objectives-based performance measures that are resident in the computer system, and which learners would not object to. For example, if an employee calls up a brief tutorial while attempting to use a software feature which is new to her, her subsequent performance using the feature could be measured and recorded by the computer system. In training settings issues of confidentiality of performance achievement may arise, so evaluators and managers together might determine whether and how employees would be informed that their performance would be tracked, and how those data would be used.

As in the earlier discussion, in these settings, data regarding learning time and self-evaluation of performance, as well as documentary and interview data could be collected.

Determining Attitudes/Perceptions

The traditional methods of collecting data on the attitudes and perceptions of learners and other stakeholders have included questionnaires and, less frequently, interviews. The traditional issues of sampling and how to compare results of instructional methods continue to apply when evaluating interactive instruction.

Questionnaires. Using quantitative methods evaluators may wish to compare the attitudes toward a subject of students who learned the subject through interactive instruction with students who participated in a traditional course. This approach was used by Savenye (1989) who found that students who participated in a full-year videdisc-based high school physical science curriculum generally held more positive attitudes toward science and how they learned science than students who took the course via traditional instruction. In this evaluation, as always, sufficient numbers of students needed to complete the surveys to yield reliable results. Additionally, care was taken to include students from various types of schools and communities, such as urban, rural and suburban, and from representative geographic areas and cultural groups in the evaluation.

If an interactive program had as its primary goal an improvement in attitudes, evaluators are likely to need to collect preinstructional and postinstructional attitude data. In a related example, Savenye, Davidson & Orr (1992) collected pre and post data, and reported that preservice teachers' attitudes toward computers were higher, and their anxiety lower, after they had participated in an intensive computer applications course.

Questionnaire items and directions should be clearly-written, and the questionnaire should be as short as possible. Questions should be directly based on the needs of the evaluation. Evaluators may wish to make most items forced-response, such as Likert-scale items, to speed data analysis. A case can be made, however, for including a few open-ended questions in every survey, to allow learners to bring up issues not anticipated by evaluators, who may be unfamiliar with the learners´ needs and concerns and constraints of their learning environment.

Interviews. Attitudes can also be measured using interviews. Often evaluators supplement questionnaires by conducting one-on-one or small, focus-group type, interviews with a small sample of learners to ensure that all relevant data were collected and nothing was missed by using a questionnaire. When budget is limited, interviews may be the sole means of collected attitude data, primarily to verify and explain achievement results. For example, Nielsen (1990) incorporated interviews into his experimental study investigating achievement effects of informational feedback and second attempt in computer-aided learning. Nielsen found that some of his learners, who not coincidentally were highly motivated Air Force cadets, who received no feedback determined that their performance depended more on their own hard work and they took longer to study the lesson, while the cadets who received the extensive informational feedback soon figured out they would receive the answers anyway, and so spent less time on the practice items.

Usually it is desirable when conducting interviews, particularly when several evaluators will be interviewing learners, for a set of structured questions to be developed. Otherwise ideosyncratic data may accidentally be collected from each learner, and data will not be comparable. In addition, it is usually useful for interviewers to be given the freedom to probe further as the interviews progress, particularly when the evaluation involves a completely new interactive system, which may be causing many types of changes in the instructional setting.

Learner Notes. In traditional field tests, evaluators often collect attitude data by allowing learners to write comments on their materials. In interactive systems, a computer program can be written to easily allow learners to write notes and comments to developers.

Other Types of Data Collection Methods. As described earlier, it may be desirable to observe learners and collect incidental attitude data, provided observers have agreed what type of data they will record. Additional data can also come up in interviews or through collecting documentary data. One example of such data was the observation by teachers and evaluators in many schools which used a videodisc-based science curriculum that many more students were coming into the science classrooms to "play" with the science lessons during their free time than ever occurred when traditional science lessons were being used.

An exemplary study using alternate research methods to determine teacher perceptions of competency-based testing serves as an example of what can be done to measure attitudes and perceptions. Higgins and Rice (1991) conducted a three-phase study. They initially conducted relatively unstructured interviews with six teachers regarding the methods they used to assess their students, and in what situations they used the techniques. From these interviews the researchers constructed a taxonomy of assessments methods. These researchers the employed trained observers to collect data during ten hours of classroom observations regarding how teachers measured their students. Subsequent interviews were conducted to ask teachers their perceptions of how they were using assessments during their classes, and to have teachers rank their perceptions of the utility and similarity of the types of assessments the teachers had described. The interview and observation data were coded and summarized. The rankings from the teacher interviews were used to perform multimensional scaling, which yielded a two-dimensional representation of the teachers' perceptions. Similar techniques could be adapted by evaluators to answer questions related to instructor and learner perceptions of their technology-based lessons, or their attitudes toward content and skills learned.

Evaluating Use/Implementation

It is in answering questions related to how the interactive instruction is being used in the various learning settings that evaluators can most profitably use alternate methodologies. The most efficient, and therefore, first methods to use to answer implementation questions are still questionnaires and interviews. However, sometimes the question when using a truly new technology is often, "What is really happening here," as opposed to what developers may plan to or hope to happen. Here we especially need answers that ring true, and here we sometimes do not know the right questions to ask. Using an anthropological approach, evaluators can go into their learning settings with an open mind.

Participant Observation. Participant observation is a technique derived from ethnographic studies. It involves intensive observation of partipants in a setting. Anthropologists may spend years "in the field" becoming in a sense members of a community, therefore participants, while they observe and record the patterns and interactions of people in that community.

Evaluators often cannot, nor do they need to, spend as much time in their instructional settings, as do anthropologists, yet the activity is extremely labor-intensive, and data collection is usually limited to those data which will answer the questions at hand. Still, evaluators would do well to remember that although they do not spend years observing the particular instructional community, they do quickly become participants. Their presence may influence results, and their experience may bias what they observe and record. In subsequent reports, therefore, this subjectivity can simply be honestly acknowledged.

Methods of collecting observational data may include writing down all that occurs, or recording using a limited checklist of behaviors. Observers can watch and write as they go, or data can be collected using videotapes or audiotapes. As mentioned earlier, analyzing qualitative data is problematic. Every behavior that instructors and students engage in could potentially be recorded and analyzed, but this can be costly in money and hours, and would most likely be useless for evaluation purposes. Evaluators should determine in advance what they need to find out.

For example, Savenye & Strand (1989) in the initial pilot test and Savenye (1989) in the subsequent larger field test of the science videodisc curriculum described earlier determined that what was of most concern during implementation was how teachers used the curriculum. Among other questions, developers were interested in how much teachers followed the teachers' guide, the types of questions they asked students when the system paused for class discussion, and what teachers added to or didn't use from the curriculum. A careful sample of classroom lessons was videotaped and the data coded. For example, teacher questions were coded according to a taxonomy based on Bloom's (1984), and results indicated that teachers typically used the system pauses to ask recall-level, rather than higher-level questions. Analysis of the coded behaviors for what teachers added indicated that most of the teachers in the sample added examples to the lessons that would add relevance to their own learners, and that almost all of the teachers added reviews of the previous lessons to the beginning of the new lesson. Some teachers seemed to feel they needed to continue to lecture their classes, therefore they duplicated the content presented in the interactive lessons. Developers used the results of these evaluations to make changes in the curriculum and in the teacher training that accompanied the curriculum. Of interest in this evaluation was a comparison of these varied teacher behaviors with the student achievement results. Borich (1989) found that learning achievement among students who used the interactive videodisc curriculum was significantly higher than among control students. Therefore teachers had a great degree of freedom in using the curriculum and the students still learned well.

If the student use of interactive lessons was the major concern, evaluators might videotape samples of students using an interactive lesson in cooperative groups, and code student statements and behaviors, as did Schmidt (1992).

Reporting Results

How the results of formative evaluations are reported depends on how the results are to be use. For example, if the report is for a funding source, or to ensure continuing support for a large project, the report might be quite formal and detailed. In contrast, if the results of the formative evaluations are for immediate use by the development team only, the reports may consist of informal summaries, memos and briefings.

The primary rule in reporting is to keep it simple. Long evaluation reports may not be read by those who most need them.

The organization of the report may best be accomplished by using the evaluation questions as headings and answering each question in the sequence the audience most likely would desire.

At a minimum the report should usually include sections on learning achievement, attitudes, and use/implementation. With regard to achievement, at least the major mean scores should be reported, with a summary table typically included. Results of any statistical comparisons may be reported. Finally other learning results or anecdotal data related to performance, such as the results of interviews, observations, or analysis of products or documentary data should be reported here (cf. Dick & Carey, 1990).

When reporting attitudes, the primary findings related to the evaluation questions can be described. It may be desirable to summarize the results of survey items on a copy of the survey or of interviews on a copy of the interview protocol. Again, summaries of other types of data collected may be written, or presented in tables.

Reporting the results on use or implementation questions may be more difficult. Results of surveys and interviews can be done in a traditional manner, however, reporting results of observations and microanalyses of data can be done many different ways. Frequency tables can be developed for categories of coded behaviors. Although not an evaluation study, pre se, an example of the reporting of teacher perceptions and planning behaviors reported in a case study style is presented by Reiser and Mory (1991). Alternately, some evaluators build a type of story description, or scenario, of patterns they have observed. It may be useful for evaluators to turn to descriptions of qualitative research in social sciences for types of methods to try (cf. Bogdan & Biklen, 1982; Straus, 1987).

Conclusions/Recommendations

In conclusion, alternate methods of conducting formative evaluations may be particularly useful and crucial when dealing with highly innovative interactive technology-based instruction. One key to success is to ensure that evaluation questions drive the choice of methods for collecting data and reporting results. Another is to keep the evaluation focussed, thus simple and efficient. Another factor in success is to use rigorous techniques and methods while experimenting with new ways of conducting evaluations. Evaluators will learn more about how their innovative technology systems are being used if they are open to what is really occurring, but not overwhelmed to the point that they gather too much data, collect data haphazardly, or focus on data items which are so ideosyncratic that the results cannot be compared to any other data or results of any other studies.

As always, the main question is whether students learned using the interactive instruction, no matter how attractive the "bells and whistles."

References

Ambron, S., & Hooper, K. (Eds.). (1988). *Interactive multimedia: visions of multimedia for developers, educators, & information providers.* Redmond, WA: Microsoft Press.

Ambron, S., & Hooper, K. (Eds.). (1990). *Learning with interactive multimedia: developing and using multimedia tools in education.* Redmond, WA: Microsoft Press.

Ambrose, D. W. (1991). The effects of hypermedia on learning: a literature review. *Educational Technology, 31* (12), 51-55.

Andrews, D. H., & Goodson, L. A. (1980). A comparative analysis of models of instructional design. *Journal of Instructional Development, 3* (4), 2-16.

Bloom, B. S. (1984). *Taxonomy of educational objectives. Handbook 1: cognitive domain*. New York: Longman.

Bogdan, R. C., & Biklen, S. K. (1982). *Qualitative research for education: an introduction to theory and methods*. Boston, MA: Allyn and Bacon.

Borich, G. D. (1989). *Outcome evaluation report of the TLTG Physical Science Curriculum, 1988-89.* Austin, TX: Texas Learning Technology Group of the Texas Association of School Boards.

Bosco, J. (1986). An analysis of evaluations of interactive video. *Educational Technology, 16* (5), 7-17.

Brenneman, J. (March 1989). When you can't use a crowd: single-subject testing. *Performance & Instruction*, 22-25.

Chen, J. W., & Shen, C.-W. (September, 1989). Software engineering: a new component for instructional software development. *Educational Technology, 9*, 9-15.

Chinien, C. (October, 1990). Paradigms of inquiry for research in formative evaluation. *Performance & Instruction*, 26-29.

Clark, R. E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53* (4), 445-459.

Clark, R. E. (1989). Current progress and future directions for research in instructional technology. *Educational Technology Research and Development, 37* (1), 57-66.

Darabi, G. A., & Dempsey, J. V. (1989-90). A quality control system for curriculum-based CBI projects. *Journal of Educational Technology Systems, 18* (1), 15-31.

DeBloois, M. L. (1988). *Use and effectiveness of videodisc training: a status report.* Falls Church, VA: Future Systems, Inc.

Dick, W., & Carey, L. (1990). *The systematic design of instruction* (3rd ed.). Glenview, Illinois: Scott, Foresman.

Driscoll, M. P. (1991). Paradigms for research in instructional systems. In G. Anglin (Ed.) *Instructional technology past present and future.* Englewood, CO: Libraries Unlimited.

Ericsson, K. A., & Simon, H. A. (1984). *Protocol analysis - verbal reports as data*. Cambridge, MA: MIT Press.

Fuchs, L. S., & Fuchs, D. (1986). Effects of systematic formative evaluation: a meta-analysis. *Exceptional Children, 53*, (3), 199-208.

Gagne, R. M., Briggs, L. J., & Wager, W. W. (1988). *Principles of instructional design.* (3rd ed.). New York: Holt, Rinehart and Winston.

Gagne, R. M., Wager, W. W., & Rojas, A. (1981). Planning and authoring computer-assisted instruction lessons. *Educational Technology, 21*, 17-26.

Geis, G. L. (May/June, 1987). Formative evaluation: developmental testing and expert review. *Performance & Instruction*, 1-8.

Hannafin, J. J. (1985). Empirical issues in the study of computer-assisted interactive video. *Educational Communications and Technology Journal, 33* (4), 235-247.

Hannafin, M. J., & Peck, K. L. (1988). *The design, development, and evaluation of instructional software.* New York: Macmillan Publishing Co.

Hannafin, M. J., & Rieber, L. P. (1989). Psychological foundations of instructional design for emerging computer-based instructional technologies: Part 1. *Educational Technology Research and Development, 37* (2), 91-101.

Higgins, N., & Rice, E. (1991). Teachers' perspectives on competency-based testing. *Educational Technology Research and Development, 39* (3), 59-69.

Higgins, N., & Sullivan, H. (1982). Preparing special education teachers for objectives-based instruction. *Teacher Education and Special Education, 5* (4), 51-55.

Hirumi, A., Savenye, W., & Allen, B. (1989, February). *Convergent technologies and public information: using videodiscs to interactivate museum exhibits.* Paper presented at the annual meeting of the Association for Educational Communications and Technology, Dallas, Texas.

Hooper, S., & Hannafin, M. J. (1988). Learning the ROPES of instructional design: guidelines for emerging interactive technologies. Educational Technology, 28, 14-18.

Jacob, E. (1987). Qualitative research traditions: a review. Review of Educational Research, 57 (1), 1-50.

Kearsley, G. P., & Frost, J. (1985). Design factors for successful videodisc-based instruction. Educational Technology, 25 (3), 7-13.

Kulik, J. A., Bangert, R. L., & Williams, G. W. (1983). Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 75 (1), 19-26.

Kulik, J. A., Kulik, C., & Cohen, P. (1980). Effectiveness of computer-based college teaching: a meta-analysis of findings. Review of Educational Research, 50 (4), 525-544.

Lambert, S., & Sallis, J. (Eds.) (1987). CD-I and interactive videodisc technology. Indianapolis, IN: Howard W. Sams.

Linn, R. L., Baker, E. L., & Dunbar, S. B. (1991). Complex, performance-based assessment: expectations and validation criteria. Educational Researcher, 20 (8), 15-21.

Markle, S. M. (August, 1989). The ancient history of formative evaluation. Performance & Instruction, 27-29.

McLean, R. S. (1989). Megatrends in computing and educational software development. Education & Computing, 5, 55-60.

McNeil, B. J., & Neson, K. R. (1991). Meta-analysis of interactive video instruction: a 10 year review of achievement effects. Journal of Computer-Based Instruction, 18 (1), 1-6.

Morris, L. L., & Fitz-Gibbon, C. T. (1978) Evaluator's Handbook. Beverly Hills: Sage Publications.

Newman, D. (March, 1989). Formative experiments on technologies that change the organization of instruction. Paper presented at the annual conference of the American Educational Research Association, San Fransisco, CA.

Nielsen, M. C. (1990). The impact of informational feedback and a second attempt at practice questions on concept learning in computer-aided learning. (Unpublished doctoral dissertation, The University of Texas at Austin).

Patterson, A. C., & Bloch, B. (November, 1987). Formative evaluation: a process required in computer-assisted instruction. Educational Technology, 27, 26-30.

Reeves, T. C. (1986). Research and evaluation models for the study of interactive video. Journal of Computer-Based Instruction, 13 (4), 102-106.

Reigeluth, C. M. (1989). Educational technology at the crossroads: new mindsets and new directions. Educational Technology Research and Development, 37 (1), 67-80.

Reiser, R. A., & Mory, E. H. (1991). An examination of the systematic planning techniques of two experienced teachers. Educational Technology Research and Development, 39 (3), 71-82.

Savenye, W. C. (1986a). A design for the evaluation of comptuer-based software. Austin, Texas: Instructional Technology Area: The University of Texas at Austin.

Savenye, W. C. (1986b, February). Instructional design considerations in development and production of an interactive videodisc for computer-based instruction. Paper presented at the annual meeting of the Association for Educational Communications and Technology, Las Vegas, NV.

Savenye, W. C. (1989) Field test year evaluation of the TLTG interactive videodisc science curriculum: effects on student and teacher attitude and classroom implementation. Austin, TX: Texas Learning Technology Group of the Texas Association of School Boards.

Savenye, W. C. (1990). Instructional interactive video - what works?. Young Academic Monograph. Washington, DC: National Society for Performance and Instruction.

Savenye, W. C., Davidson, G. V., & Orr, K. B. (1992, in press). Effects of an educational computing course on preservice teachers' attitudes and anxiety toward computers. The Journal of Computing in Childhood Education.

Savenye, W. C., & Strand, E. (1989, February). Teaching science using interactive videodisc: results of the pilot year evaluation of the Texas Learning Technology Group Project. In M. R. Simonson, & D. Frey (Eds.), Eleventh Annual Proceedings of Selected Research Paper Presentations at the 1989 Annual Convention of the Association for Educational Communications and Technology in Dallas, Texas. Ames, IA: Iowa State University.

Schmidt, K. J. (1992). At-risk eighth grade student feelings, perceptions, and insights of computer-assisted interactive video. (Unpublished doctoral dissertation, The University of Texas at Austin).

Schwartz, M. (1982). Designing interactive video programs. In S. Floyd & B. Floyd Handbook of interactive video. White Plains, NY: Knowledge Industry Publications.

Schwier, R. (1987) Interactive video. Englewood Cliffs, NJ: Educational Technology Publications.

Slee, E. J. (1989). A review of research on interactive video. In M. R. Simonson, & D. Frey (Eds.), Eleventh Annual Proceedings of Selected Research Paper Presentations at the 1989 Annual Convention of the Association for Educational Communications and Technology in Dallas, Texas (pp. 150-166). Ames, IA: Iowa State University.

Smith, P. L., & Boyce, B. A. (1984). Instructional design considerations in the development of computer-assisted instruction. Educational Technology, 24, 5-11.

Smith, P. L., & Wedman, J. F. (1988). Read-think-aloud protocols: A new data-source for formative evaluation. Performance Improvement Quarterly, 1 (2), 13-22.

Steinberg, E. R. (1989). Cognition and learner control: a literature review, 1977-1988. Journal of Computer-Based Instruction, 16 (4), 117-121.

Straus, A. L. (1987). Qualitative analysis for social scientists. Cambridge: Cambridge University Press.

Sullivan, H., & Higgins, N. (1983). Teaching for Competence, New York: Teacher's College Press, Columbia University.

The power of multimedia: a guide to interactive technology in education and business. (1990) Washington, DC: Interactive Multimedia Association.

U. S. Congress, Office of Technology Assessment. (1988, September). Power On! New Tools for Teaching and Learning (OTA-SET-379). Washington, DC: U. S. Government Printing Office.

Winn, W. (1989). Toward a rationale and theoretical basis for educational technology. Educational Technology Research and Development, 37 (1), 35-46.

Title:

Students' Attitudes Toward Small Group CBI: A Question of Aptitude

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Students' Attitudes Toward Small Group CBI:
A Question of Aptitude

ABSTRACT

This investigation examined middle-school students' attitudes toward and abilities to benefit from small group computer-based instruction (CBI) as a function of their academic aptitudes, gender, and learning situations. Two studies were conducted with different tasks. Seventy-six seventh graders (39 high aptitude and 37 low aptitude) from a suburban school completed a task designed for individual performance; while a group of 56 students from an inner-city middle school completed a task designed for small group performance. After completing the tasks designed for individualized performance, higher ability students preferred individualized CBI and lower ability students preferred small group CBI; while the opposite set of preferences was found for the small group learning task. A complex interaction was then proposed among students' academic aptitudes, their preferences for small group or individualized CBI, and the learning situation.

Introduction

Foremost among many recent trends in education has been a surge of interest in cooperative learning. A computer search of the ERIC system produced 628 professional works during the last seven years on this topic as compared to 105 such works from 1965 to 1982.

Underlying this trend is the belief that cooperative learning situations can help educational programs and systems throughout the world meet some of their pressing practical concerns. For example, current economic problems have made it impossible for the U.S. school systems to have enough computers to meet the needs of every student (Becker, 1990; Sutton, 1991). These economic concerns have also led to a greater disparity in the accessibility of computers to students from affluent and poor schools with students from the latter schools having very limited access to this instructional medium (Sutton). Cooperative or small group use of computers can thus allow more students--especially those from disadvantaged communities--to use this instructional medium.

Small group learning is also expected to give students a more positive attitude toward the instructional process (Smith, 1987). Such claims about cooperative learning's enhancement of student motivation, especially that of marginal students appears throughout the educational literature (Glaser, 1985; Hooper & Hannifan, 1991; Johnson, Johnson, & Stanne, 1983; Mensch, Lew, Johnson, & Johnson, 1986; Sharan, 1990; Slavin, 1987). Hooper and Hannafin (1991) have noted that students working individually for extended periods often become lonely, bored, or frustrated with their work. Also, individualized work tends to make at-risk students feel more isolated from their peers (Mensch et al.). Small group use of computer-based instruction (CBI) should thus help students overcome these problems of frustration and isolation as students provide each other with moral support (Hooper & Hannafin; Rysavy & Sales, 1991). It is generally believed that helping students to overcome such feelings helps students to reach higher levels of academic achievement (Hooper & Hannifan; Rysavy & Sales, 1991).

An aptitude-by-treatment interaction (ATI) may exist in students' preference for small group learning (Sharan & Shaulov, 1990). Pyryt (1991) has intimated that higher ability students are more oriented toward individualistic learning situations than cooperative learning situations as these students prefer competitive activities. Lower ability students seem to prefer cooperative learning situations as these learning environments provide them with needed structure and moral support. Hence, lower ability students would seemingly prefer and benefit from small group CBI while higher ability students would find individualistic CBI situations more beneficial.

Clark (1982) found evidence that suggests a different relationship between students' abilities and preferences toward individualistic and small group CBI. Lower ability students were found to prefer activities that promised them relative anonymity while higher ability students tended to prefer the more structured tasks. According to Clark's evidence, lower ability students would tend to favor individualistic CBI over small group CBI while the opposite preference would be found for higher ability students.

Dalton, Hannafin, and Hooper (1989) did find further empirical support for lower ability students' preference for anonymity. This investigation, which involved students' learning scientific materials, found a complex interaction among students' gender, ability levels, and preferences for dyadic or individualized use of CBI materials. Lower ability males tended to prefer individualistic CBI while their female counterparts preferred cooperative CBI. They claimed that the lower ability male students' desire for anonymity was due to the learning situation associated with their study. That is, male middle-school students did not want other students to realize that their knowledge of science was limited. The reasons for lower ability females' preference for cooperative CBI were not discussed. They also failed to mention other aspects of this learning situation, such as the composition of the groups, which might have affected the lower ability male students' desires for anonymity. Finally, Dalton et al. did not find any ATI effects in the students' achievement scores.

Except for the evidence provided by Dalton et al., very little empirical data exist regarding the possible ATI effects in students' preferences for and abilities to benefit from small group use of computer technology. Hence, many questions remain regarding such possible ATI effects, including their very existence.

Purpose of Investigation

The primary purpose of this investigation was to examine middle-school students' preferences for and abilities to benefit from either small group or individualized CBI as a function of their academic aptitudes, learning situation and gender. Also examined were the students preferences for: (a) small group CBI versus not working at the computer and (b) working with a partner versus working with partners at terminals. A final issue involved changes in the students' preferences as a function of their learning experiences. These later issues have also not been fully explored by the research literature (see Shlechter, 1991).

Research Approach

Two studies were conducted employing completely different learning situations. One group of students completed a science task designed for individualized learning with individualized measures of performance being utilized. A second group used the computer to complete a social studies task designed for small group learning. The performance measure for this study was the group's completion of the task. Also, homogeneous ability groupings were employed for Study 1 while both homogeneous and heterogeneous ability groupings were employed for Study 2.

Each study was conducted as part of the schools' academic program. All studies were also conducted during regularly scheduled class sessions in the schools' computer laboratories. The subjects were neither encouraged nor discouraged from engaging in cooperative activities. Previous studies have shown that students who are working together at terminals are rarely instructed to engage in cooperative behaviors (see Littlejohn, Ross, & Gump 1984; Shlechter, 1991).

Study 1

Method

Subjects: This sample consisted of eighty seventh graders (40 high and 40 low aptitude) from a suburban middle-school in the greater Phoenix, AZ area. Half of these students had a high aptitude for science, as determined by teacher nominations, and the other half had a low aptitude. Four students did not complete the task leaving 39 high aptitude students and 37 low aptitude students.

Training Conditions: Subjects were assigned to one of three training conditions: small group (four per terminal), dyad (two per terminal), or individual (by themselves). While each condition had approximately the same mix of high and low ability students, students were assigned to homogeneous ability working arrangements. Students in the small group and dyad training conditions were also arranged into either same and mixed sex groupings with approximately the same number of male-male; female-female, and female-male working arrangements.

Instruments: A 13 item continuing motivation questionnaire was adopted from one previously used by Pollock (1989). Each item involved the students in responding to one of two preferences, such as:

I would prefer to work on the computer:
a. with several partners.
b. by myself.

Five of these items dealt with assessing students' preferences for: (a) small group versus individualized CBI; (b) dyadic versus quadratic terminal arrangements; and (c) small group versus not working at the computer. The remaining eight items dealt with students' feelings regarding the subject matter and regarding the use of computers.

The immediate and delayed post-tests consisted of 30 short-answer completion questions, which were previously used by Pollock (1989). She found that the different tests were psychometrically sound with KR21 reliability coefficients in the .70s.

Procedure: The students completed a CBI instructional program on tarantulas, which was previously used by Pollock (1989). This lesson contained embedded multiple-choice and short-answer completion questions. Subjects who were told to work at their own pace took approximately fifty minutes to complete this task. Subjects, individually, completed the attitudinal questionnaire and the achievement test. Six weeks later they took, individually, the delayed post-test.

Dependent Variables and Data Analyses

Preference Data: The dependent variables for the attitudinal measures were the students' responses to items dealing with small group and individualized CBI. Separate 2 X 2 chi-square analyses per item were conducted to determine the existence of any aptitude difference in these data. The cross-break variables for these different chi-square analyses were the subjects' aptitudes (high or low) by their responses to each of the two choices per item--e.g., working with a partner or by themselves.

4 X 2 chi-square analyses were also computed to examine any possible interaction between aptitude and gender. The factors for these analyses were four groups of subjects--(a) low aptitude females; (b) high aptitude females; (c) low aptitude males; and (d) high aptitude males--by response frequencies for each choice. These chi-square analyses were conducted upon the subjects' responses for working with a partner and with partners.

All chi-square tests were computed for proportional differences in the data. The computer program--SPSSx--was used to compute these tests with the alpha level being set at .05.

Performance Data: The dependent variables for these data were the subjects' scores on the different tests. These data were analyzed by the following ANOVA model--a 3 X 2 X 2 X 2 factorial for repeated measures. As previously indicated, these factors included three levels of group size (small group, dyad, and individualized CBI); two levels of gender (male and female), two levels of scientific aptitude (high and lower aptitude students); and two levels of tests (immediate post-test versus delayed post-test), which were the repeated dimension of the ANOVA model

Again, SPSSx was used to compute the analyses. And the alpha level was set at .05 for all tests.

Results

A significant relationship was found with regards to aptitude differences and students' preferences for working with a partner, $\underline{X}^2$ (1, $\underline{N}$ = 76) = 4.53, $\underline{p} < .03$). Also, a trend approaching significance was found with regards to working with partners, $\underline{X}^2$ (1, $\underline{N}$ = 76) = 3.33; $\underline{p} > .07$). Seventy percent of the lower ability students preferred working on the computer with an assigned partner rather than working by themselves. Only 46% of the higher ability subjects had the same preference. Nearly 55% of the lower aptitude students favored working on the computer in an assigned group of four as compared to only 30% of the higher aptitude students.

There was a marginally significant interaction between gender and aptitude regarding the subjects' preferences for working with a partner, X^2 (3, N=76)=7.35; $\underline{p} > .06$). A substantially lower percentage of higher ability males favored working with a partner than did any other group. However, this interaction was not significant for the subjects' preferences for working with partners.

Several other interesting patterns emerge from the preference data. Subjects overwhelmingly preferred to work with a partner rather than with partners. They preferred working in small groups rather than not working at a computer. An interesting aside is that subjects--regardless of aptitude and sex--preferred to study something other than insects on the computer.

Performance Data: The ANOVA test failed to find any significant effects nor interactions associated with group size. Students thus learn and retain comparable amounts of information regardless of the CBI mode of presentation.

STUDY 2

Method

Subjects: The subjects were fifty-six (38 females and 18 males) seventh graders from Louisville, KY. The principal indicated that this sample consisted of 12 low aptitude (4 females and 8 males), 12 average students (7 females and 5 males), and 32 (27 females and 5 males) high aptitude students.

This school is located in a racially mixed working class neighborhood with a public housing project nearby. According to guidelines in the Jefferson (Kentucky) County Schools, the school has a 60-40% black-to-white ratio.

Tasks and Procedure: Several methodological changes were made from Study 1. As previously indicated, the students developed two different spreadsheets for use in a social science course. Each task took two fifty-minute class periods to complete. A second change was the matter in which the working arrangements were determined. To replicate daily computer usage, the students determined their own working arrangements for the first task. Nearly all of them chose to work with same sex partners rather than by themselves. Also, most of these groups consist of students with relatively similar academic abilities. That is, groups would rarely consisted of students with high and low aptitudes. Five students did choose to work by themselves. No systematic patterns were found in the students' desire to work by themselves vis-a-vis aptitude differences.

For the second task, students were assigned to work at a terminal with other students. This was done to force all students to work together and with classmates who were not necessarily their friends. Nearly all of the assigned groups for this task consisted of students with differing abilities and sexes.

A final set of changes dealt with the preference questionnaire. The subjects completed this questionnaire before and after completing the computer lessons. Also, the questionnaire was slightly changed to assess the terminal arrangements employed in this study. Questions about working with friends were added while those about working with a partner were eliminated.

Dependent Variables and Data Analyses: The dependent variables for the attitudinal measures were the students' responses to each item. 2 x 2 chi-square analyses were conducted for both the initial and final questionnaire data with the cross-break variables being low and high aptitudes by: (a) partners or self and (a) friends and self. Middle aptitude students who were not the focus of this investigation were eliminated for these analyses. Also, the possible "interaction" between gender and aptitude was not examined due to the limited number of females and males in the low and high aptitude groups, respectively.

The performance measure was the teacher's indications of the different groups' abilities to complete the assignment. However, it was not possible to analyze these data as the teacher indicated that all groups did complete the assignment with very little difficulty.

All chi-square tests were computed for proportional differences in the data. SPSSx was used to compute these tests with the alpha level being set at .05.

Results

A significant relationship existed in students' initial preferences toward working with friends--$\underline{X}^2$ (1, $\underline{N}$ = 44)= 4.53, $\underline{p} < .03$--and partners $\underline{X}^2$ (1, $\underline{N}$ = 44)= 4.93, $\underline{p} < .03$. Three-quarters of the low aptitude students had an initial preference for working with several friends rather than working by themselves while nearly 63% of the higher ability students had the opposite preference.

A significant relationship was also found for the subjects' final preferences for working with partners or by themselves, $\underline{X}^2$ (1, $\underline{N}$ = 44) = 6.38, $\underline{p} < .01$. Nearly 70% of the higher ability students' preferred working with partners while two-thirds of the low aptitude students had the opposite preference. A comparable but non-significant trend was found for the subjects' preferences for working with friends or by themselves.

Additional chi-square analyses indicated that these reported relationships between the initial and final preference questionnaire were significant for:

(1) high aptitude student' preferences for working with friends, $\underline{X}^2$ (1, $\underline{N}$ = 64)= 7.63, $\underline{p} < .01$.

(2) high aptitude students' preferences for working with assigned partners, $\underline{X}^2$ (1, $\underline{N}$ = 64) =5.11, $\underline{p} < .02$.

and (3) lower aptitude students' preferences for working with assigned partners, $\underline{X}^2$ (1, $\underline{N}$ = 64) = 6.17, $\underline{p} < .01$.

Hence, engaging in small group CBI did have a significant effect on these students' preferences for small group or individualized CBI. Several other interesting patterns emerge from these data. One, subjects--regardless of aptitude--overwhelmingly preferred to working in small groups to not working at a computer. Nearly all of them found that these exercises were either very easy or easy to complete and preferred to working with friends over working with partners. Gender effects were not found in these data.

Summary and Conclusions

Several interesting trends have emerged from this investigation's data. One, as previously described, differences were found for most measures regarding students' preferences for small group or individualized CBI. Hence, a aptitude-by-treatment interaction does seemingly exist between students' preferences for small group or individualized CBI and their academic abilities.

Two, this ATI effect does appear to be a function of "state factors" (i.e, the learning situation) rather than any inherent predisposition for small group or individualized CBI. As stated, the higher and lower aptitude students' preference data were differentially affected by the different learning situations. As found in Study 2, subjects' preferences did change as a result of engaging in small group CBI. A complex interaction might then exist among students' academic aptitudes, their preferences for small group or individualized CBI, and state factors.

This complex interaction does not seem to be contaminated by the previously discussed gender-by-aptitude interaction found in Study 1. This interaction may not have been very robust as it was a trend approaching significance. Also, comparable findings were found for Study 2's initial preference data, which included many more females than males. And, this second study dealt with examining students' preferences for working with several students rather than with a partner.

It was, however, beyond the scope of this investigation to provide any clear insights into the underlying reasons for this proposed interaction. Perhaps for the individualized learning task, the lower ability students felt that they needed help and moral support from other students whereas the higher ability students felt that other students represented competition. Higher ability students might have felt that "they could strut their stuff" in the group task while the lower ability students felt useless.

The underlying reason may have been the social composition of these groups. Study 1 was composed of homogeneous ability groupings as compared to both homogeneous and heterogeneous ability groupings for Study 2. Perhaps then, lower ability subjects felt less threatened when working with each other than when working with higher ability subjects. Correspondingly then, higher ability subjects might have felt less threatened by competition when working with lower ability subjects.

There were some indications, however, that such social factors did not totally explain the reported influences of state factors. Study 2's subjects manifested comparable preferences for working with friends and assigned partners. And these subjects were more likely to work with friends in homogeneous gender and (similar) ability groupings and with assigned partners in heterogeneous ability and gender groupings.

Whatever the underlying reasons for the proposed ATI effects, these preference data do reflect learning situations that students feel are best for them. The veracity of such feelings was not confirmed by this investigation's data. Comparable amounts of learning and retention were found across the different training conditions for the lower and higher ability students in Study 1.

This investigation's preference data can still be useful for helping educators to design their educational program. Study 1's results indicated that small group CBI should consist of dyads rather than three or four students at a terminal. Study 2's students--regardless of ability levels--preferred small group CBI to not working at a computer, which means that small group CBI can be implemented in a heavily integrated urban school. Perhaps then, small group CBI can help eliminate some of the inequities found with current computer usage in American schools.

In closing, a complex interaction appears to exist among students' academic aptitudes, their preferences for small group or individualized CBI and state factors. However, important questions regarding the underlying reasons for and possible instructional benefits associated with this interaction are left unresolved. Conceivably, further insights into these important questions will be presented at upcoming meetings of this association.

References

Becker, H. J. (1990). Computer use in United States schools: 1989. An initial report of U.S. participation in the I.E. A. computers in education survey. Paper presented at the Annual Meeting of the American Educational Research Association, Boston.

Clark, R. E. (1983). Reconsidering research of learning from media. Review of Educational Research, 53, 445-459.

Dalton, D. W., Hannafin, M. J., & Hooper, S. (1989). Effects of individual and cooperative computer-assisted instruction on student performance and attitudes. Educational Technology Research & Development, 37(2), 15-24.

Glaser, W. M. (1986). Control theory in the classroom. New York: Harpers & Row, Inc.

Hooper, S. & Hannafin, M. J. (1991). The effects of group composition on achievement, interaction, and learning efficiency during computer-based instruction, Educational Technology Research & Development, 39(3), 27-40.

Johnson, R. T., Johnson, D. W., and Stanne, M. M. (1986). Comparison of computer-assisted instruction. Journal of American Educational Research Journal, 23(3), 382-392.

Littlejohn, T. D., Ross, R. P. & Gump, P. V. (1984, April). Using computers in elementary schools: Implementation issues. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Mesch, D., Lew, M., Johnson, D. W., and Johnson, R. (1986). Isolated teenagers, cooperative learning, and the training of social skills. The Journal of Psychology, 120(4), 323-334.

Mevarech, Z. R., Stern, D., and Levita, I. (1987). To cooperate or not to cooperate in CAI: That is the question. Journal of Educational Research, 89, 164-167.

Pollock, J. C. (1989). Practice Mode and testing effects in computer-based instruction. Unpublished doctoral dissertation, Arizona State University, Phoenix.

Pyryt, M. C. (1991). Promising directions for computer-based training with gifted individuals. In T. M. Shlechter (Ed.), Problems and Promises of Computer-Based Training (pp. 139-150). Norwood, NJ: Ablex Publishing Corporation.

Rysavy, S. D., & Sales, G. C. (1991). Cooperative learning in computer-based instruction. Educational Technology Research & Development, 39(2), 70-79.

Sharan, S. (Ed.), (1990). Cooperative Learning: Theory and Research. New York: Praeger Press.

Sharan, S. & Shaulov, A. (1990) Cooperative learning, motivation to learn and academic achievement. In S. Sharan (Ed.), Cooperative Learning: Theory and Research (pp. 173-202). New York: Praeger Press.

Shlechter, T.M. (1991, November). What do we really know about small group CBT. Paper presented at the Annual Meeting of the Association for the Development of Computer-Based Instructional Systems, St Louis, MO.

Slavin, R. (1983). Cooperative Learning. New York: Longman.

Smith, R. A. (1987). A teacher's views on cooperative learning. Phi Delta Kappan. 68(9). 663-666.

Sutton, R. E. (1991). Equity and computers in schools: A decade of research. Review of Educational Research, 61(4), 475-503.

Title:

Enhancing Teacher Utilization of Complex Instructional Systems

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Introduction

It is acknowledged that nationwide schools are underfunded for technology. However it is not enough to simply throw more scarce education dollars into the voracious maw of computer hardware and related technologies and assume that all will be well. There is growing evidence that the instructional technology base currently installed in many classrooms is being underutilized. Simply providing teachers with additional computer technology is insufficient to ensure that it will be effectively implemented as an integral portion of the daily curriculum.

Although much energy is being directed towards the restructuring of schools, technology has not,as yet, been viewed as a key element in the success of these efforts. The advantages of computer technologies for enhancing instructional and learning environments are demonstratively obvious. Why are they not wholeheartedly adopted by teachers and administrators? What are the obstacles which prevent teachers from incorporating technology into the instructional arena. There are basically two categories of obstacles: limited access and ease-of-use.

Limited Access

Increasing amounts of computer technology are being placed into schools. However, in many instances this technology is still not directly accessible to the classroom teacher. Frequently the computer technology has been concentrated in limited numbers in computer labs and media centers. Teachers/classes are scheduled in the lab only two or three times a week. This pull-out model makes it difficult for teachers to integrate the classroom curriculum with the computer lab curriculum

Even when computer systems are distributed into the classroom teachers may find it difficult to gain access to the information stored on the computer. When an electronic curriculum is supported by some type of instructional management system, the system may often rigidly control how the curriculum may be used or accessed. Not only is instructional information often difficult to access on the computer, but also administrative information. Computers are capable of storing an incredible amount of data on student backgrounds and needs which is of legitimate use to the teacher. But that information does a classroom teacher little good when stored on a computer accessible only to the principal or on the district mainframe. If there is no management system the teacher is left often with even less information about how to use and integrate a wide variety of software packages from different publishers.

Ease of Use

Teachers are heavily burdened with the constraints of managing the instructional environment: student evaluation and assessment, matching individual student needs with content, sequencing instruction, recording keeping, and reporting student progress. All too often the addition of computer-based technology is perceived as one element too many in an already overtaxed situation. Teachers frequently feel they simply do not have the time or energy to master and integrate an instructional device which is perceived as complex and, all too often, as only marginally relevant to the existing curriculum. For those teachers who do make the effort, the implementation of computer-based technology ranges from providing student free-time use of software which in some way supplements the content being taught to the systematic use of computer-based tools which enhance the delivery and assimilation of instruction.

Stand alone software may support instruction of discrete objectives but is not intended to comprehensively support the entire curriculum of a specific content area let alone cross-curricular goals and objectives. Rarely does stand alone software provide the flexibility to customize the instruction based on individual needs or even monitor and/or report student progress. Integrated learning systems are designed to accomplish the above not just for one student but for an entire school. However, the down-side of this power is that the user interface for instructional management is frequently perceived as intimidatingly complex.

Most computer-based instructional management systems are outgrowths of older, larger computer systems. They were designed to be used by computer specialists, not classroom teachers. Often these systems are entirely text based and require extensive familiarity with computer operating systems and database systems. As a result, they often make the job of the classroom teacher harder, not easier.

The Renaissance Project

Beginning in late 1989, Jostens Learning Corporation undertook the development of a new generation of information management systems for public schools. Code-named the Renaissance Project, the development effort has been focussed on addressing a variety of problems which include limited access and ease of use. Efforts were at times supported and constrained by the need to develop a final product that was technically viable and economically feasible for schools today. At times, some theoretical avenues were not fully explored in order to concentrate on the sometimes more immediate and pragmatic problem of "getting the product out the door." Nonetheless, there are some empirically derived insights which may be of use to others trying to address these same issues.

Renaissance System Requirements

The development of the Renaissance Information Management System (RIMS) began with an attempt to clearly define what barriers currently existed to using computer systems in public schools. Surveys were conducted in dozens of school systems across the United States. The surveys included questionnaires from classroom teachers who used computers frequently, teachers who only occasionally used computers, teachers who had never touched a computer, school administrators, teacher's aides, parents, and community volunteers. Jostens Learning education service representatives who train school staffs on using the company's integrated learning systems were included in the surveys. One of the more useful techniques for getting information on the issues of implementing technology was the analysis of the logs of Jostens Help Line staff.

Yet another source of information and guidance was a National Advisory Council made up of expert classroom teachers, administrators, and computer specialists from across the nation. This council initially met frequently to help define the requirements for the system, and then regularly for the next two years to constantly monitor and review the development of the system itself.

As a result of this extensive data collection, several hundred requirements were defined for the new system. Classroom teachers identified access to information and professional resources as amongst the most critical attributes. Teachers wanted access to other staff members, outside experts, curriculum information, student records, collaborative learning tools, electronic references and productivity tools. They also wanted more control over curriculum delivery and student assessment. At the same time that educators were expressing the need for more control over the system they also requested a system far more sensitive and adaptive to individual student needs and conditions--an "intelligent" instructional delivery system.

RIMS is an information management user-interface for an integrated learning system which graphically portrays the school environment and borders on that of virtual reality. The intent is to provide users with tools --familiar in appearance--which easily allow for the customizing of instructional sequences and the monitoring of student progress.

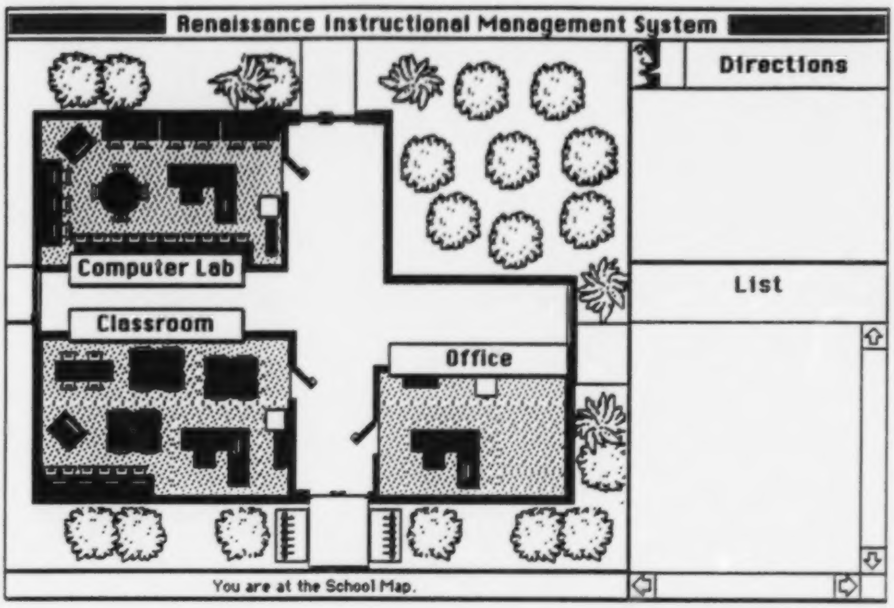
In trying to address these requirements the classic Catch 22 of product development immediately became apparent--how to add more functionality while at the same time making the system easier to use. Clearly a new type of interface system was needed. A variety of graphic interface systems (GUI) including both the Macintosh, Windows, and Next operating systems were investigated. While all of these constituted an significant improvement over previous text-based operating environments, the volume of information in the system soon became overwhelming using standard graphical interfaces so other more non-conventional interface technologies were explored.

RIMS Interface

A new technique in interface design is the creation of three dimensional, all encompassing representations of physical space. Interfaces such as these,which grew out of CAD/CAM technology, surround the user with a metaphorical space that the user can navigate through in order to act in a fashion that fits the way they would act if that space were real. This type of graphic environment is often referred to as a "virtual reality" or "cyberspace". The initial RIMS concept was to create a functional environment that would encompass an entire school building, in other words a "virtual school".

However to do so required an incredible amount of raw computer processing power and vastly more data space than would be available on affordable school computers . A simpler frame-based model was selected as a viable alternative (See Figure 1). This simplified model which employed extensive use of hypertext still allowed for the communication and representation of information in innovative ways but did not require the sheer horsepower of a complete virtual reality system.

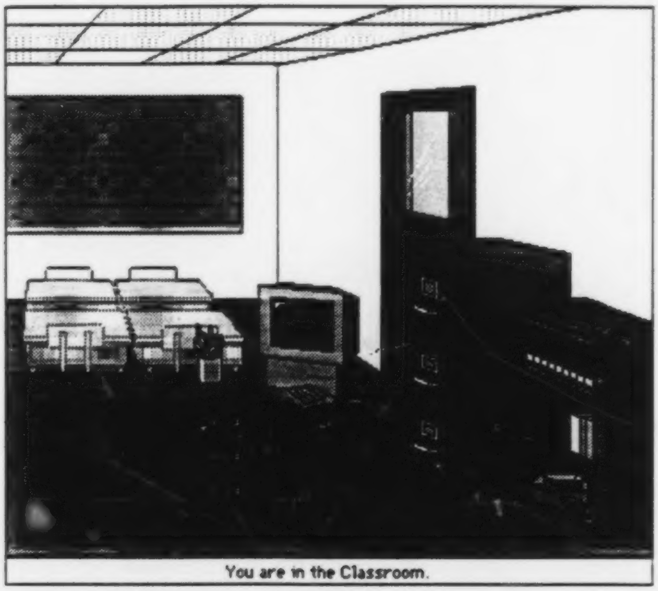
Figure 1 The Renaissance School Map


Renaissance Instructional Management System
Directions
Computer Lab
Classroom
Office
List
You are at the School Map.

A description of each of RIMS features would be prohibitively lengthy and so only two modules which are especially relevant to enhancing teacher utilization--Student Records and the Learning Path Editor--are described herein.

Entrance to the world of RIMS begins by selecting a room from the school map (See Figure 2).

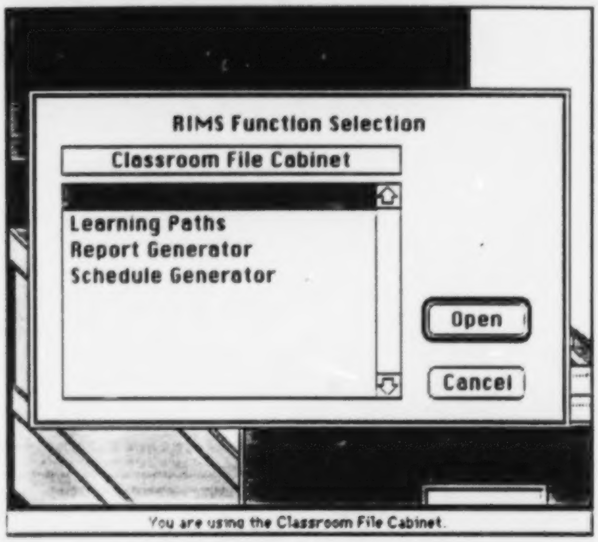
Figure 2 The Renaissance Classroom


You are in the Classroom.

The classroom display provides access to a number of information management and productivity tools: The file cabinet is the doorway to a variety of classroom management features among them student records and the sequencing of instruction. There are three basic tasks to be accomplished. Students must be entered into the system, instructional sequences must be defined, and students must be assigned to specific learning paths. It is not necessary to accomplish these tasks in the order given.

Student Records
Student records utilizes a graphic metaphor of tabbed file folders to make working with student information more intuitive. The folders are accessible by clicking on the file cabinet which results in a pop-up menu of record selections (see Figure 3).

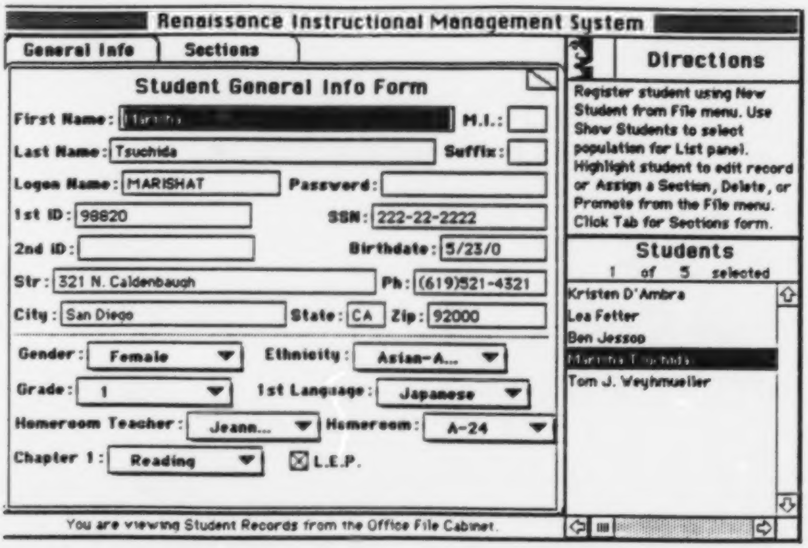
Figure 3 Access to student records from the file cabinet


RIMS Function Selection
Classroom File Cabinet
Learning Paths
Report Generator
Schedule Generator
Open
Cancel

You are using the Classroom File Cabinet.

Access to student records is controlled through special security options defined under the School Setup Module. Data on student achievement is also stored in Student Records. Teachers or administrators with the proper file privileges will be able to add, delete, or modify student records using simple pull-down menus or graphic buttons (See Figure 4).

Figure 4 Student Records


Renaissance Instructional Management System
General Info
Sections
Student General Info Form
Directions
Students

First Name: Marisha
M.I.:
Last Name: Tsuchida
Suffix:
Logon Name: MARISHAT
Password:
1st ID: 98820
SSN: 222-22-2222
2nd ID:
Birthdate: 5/23/0
Str: 321 N. Caldenbaugh
Ph: (619)521-4321
City: San Diego
State: CA
Zip: 92000
Gender: Female
Ethnicity: Asian-A...
Grade: 1
1st Language: Japanese
Homeroom Teacher: Jeann...
Homeroom: A-24
Chapter 1: Reading
☒ L.E.P.

Register student using New Student from File menu. Use Show Students to select population for List panel. Highlight student to edit record or Assign a Section, Delete, or Promote from the File menu. Click Tab for Sections form.

1 of 5 selected

- Kristen D'Ambra
- Lea Fetter
- Ben Jessop
- Marisha Tsuchida
- Tom J. Weyhmueller

You are viewing Student Records from the Office File Cabinet.

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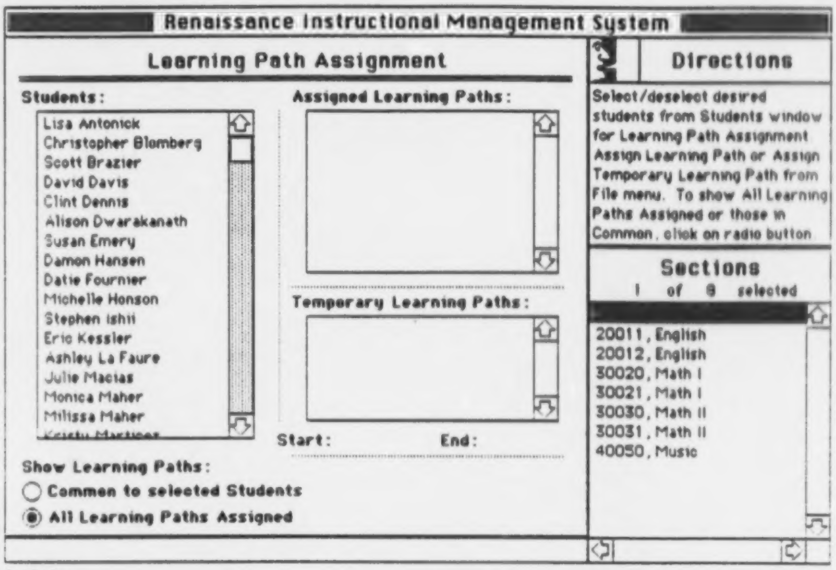
After students have been entered into the system, they must be assigned to specific instructional sequences or Learning Paths (See Figure 5). Students can be assigned to Learning Paths in entire sections, as individuals, or even on a temporary basis.

Figure 5 Learning Path assignment


Renaissance Instructional Management System
Learning Path Assignment
Directions
Assigned Learning Paths:
Temporary Learning Paths:
Start:
End:
Sections

Students:

Lisa Antonick
Christopher Blomberg
Scott Brazier
David Davis
Clint Dennis
Alison Dwarakanath
Susan Emery
Damon Hansen
Datie Fournier
Michelle Honson
Stephen Ishii
Eric Kessler
Ashley La Faure
Julie Macias
Monica Maher
Milissa Maher

Show Learning Paths:

○ Common to selected Students
● All Learning Paths Assigned

Select/deselect desired students from Students window for Learning Path Assignment Assign Learning Path or Assign Temporary Learning Path from File menu. To show All Learning Paths Assigned or those in Common, click on radio button

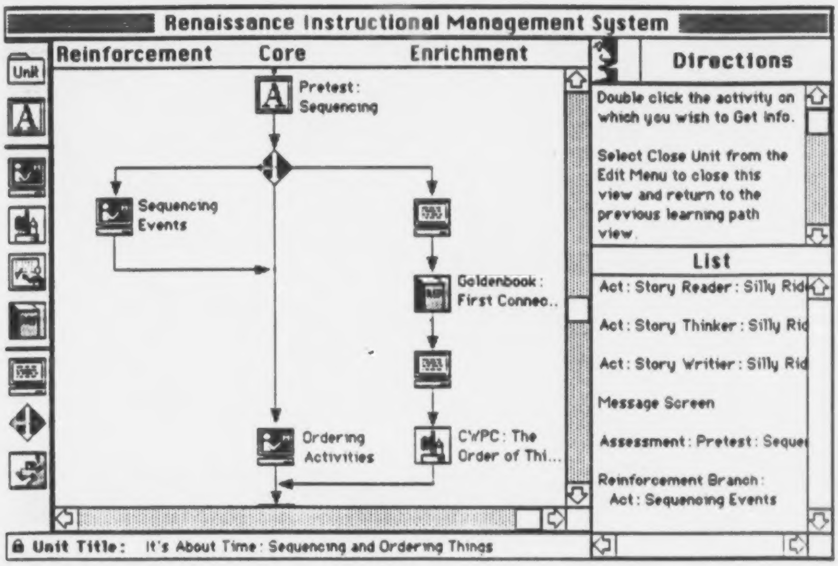
1 of 8 selected

20011, English
20012, English
30020, Math I
30021, Math I
30030, Math II
30031, Math II
40050, Music

The Learning Path Editor

In an effort to provide educators with the power to customize instruction and student assessments a tool called the Learning Path Editor (LPE) was created. RIMS is designed to ensure that students have the prerequisite knowledge needed before being allowed to enter a unit of instruction. Teachers also wanted the system to "automatically" branch to remediation or to enrichment activities whenever appropriate (See Figure 6). The RIMS system provides a high degree of sophistication in directing the activities of students while also providing educators the power to override the system at any time.

Figure 6 Renaissance Learning Path


Renaissance Instructional Management System
Unit
Reinforcement
Core
Enrichment
Pretest: Sequencing
Sequencing Events
Goldenbook: First Connec..
Ordering Activities
CWPC: The Order of Thi...
Directions
List

Double click the activity on which you wish to Get Info.

Select Close Unit from the Edit Menu to close this view and return to the previous learning path view.

Act: Story Reader: Silly Rid
Act: Story Thinker: Silly Rid
Act: Story Writier: Silly Rid
Message Screen
Assessment: Pretest: Seque
Reinforcement Branch:
  Act: Sequencing Events

Unit Title: It's About Time: Sequencing and Ordering Things

7 ·5

The LPE allows the customer to easily construct branched instructional sequences and assessments using an object oriented graphic system. Required elements (assessment, core instruction, remediation, enrichment, reference tools) need only be clicked and dragged into place from the menu bar to define an instructional sequence. As the LPE was developed it became apparent that the sheer volume of materials available to the user was overwhelming. There were literally thousands of lessons, tools, and tool templates available to any teacher who wished to create a instructional sequence. It would be impossible for any teacher to become readily familiar with such a large body of material. An underlying hypertext system was created which allowed teachers to browse through descriptions of any material for potential inclusion into the electronic curriculum.

Figure 7 Learning Path unit level

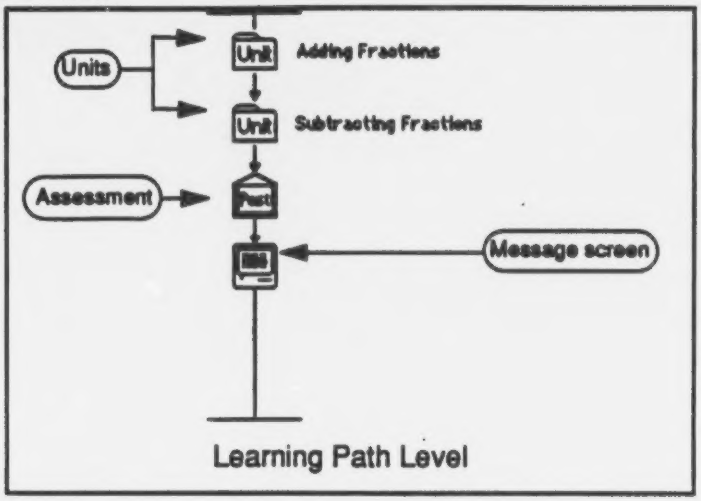
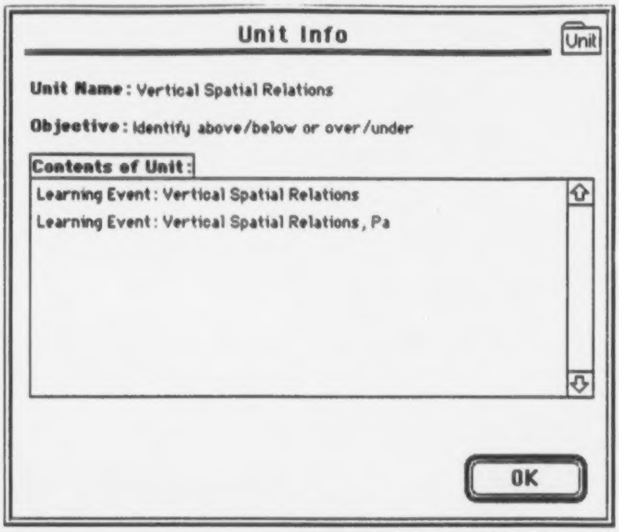


Figure 7 is a sample screen display of an instructional sequence at the unit level . Descriptions of each curriculum component are provided at the click of the mouse. Clicking on the unit icon and selecting Get Info provides the teacher with detailed information about the instructional content of that specific unit (See Figure 8). The general objective is listed as are each of the lessons provided in the unit. Clicking on the Learning Event produces a more detailed listing of the specific objectives for the lesson. As a navigational feature the source icon is depicted in the upper right corner.

Figure 8 Unit level information



Unit Name: Vertical Spatial Relations

Objective: Identify above/below or over/under

Contents of Unit:

Learning Event: Vertical Spatial Relations
Learning Event: Vertical Spatial Relations, Pa

Conclusion

Jostens Learning has assessed the needs of educators and has developed a user interface designed to empower the management of information and technology access in the classroom The pragmatic limits and implications of providing such interfaces for educators are being explored in hopes that computer-based instructional technologies will be more readily employed in schools to provide optimal instructional environments for students. The next step is to evaluate the effectiveness of these new tools in meeting the needs of educational information management for the classroom teacher, students, administrators, and parents.

Title:

A Study of Black At-Risk Urban Youth Using Computer Assisted Testing

Author:

Barbara R. Signer

Author Notes

This paper is part of the study "CAI and At-Risk Minority Urban High School Students." The full text of the study will soon appear in the Journal of Research on Computing in Education.

A Study of Black At-Risk Urban Youth Using Computer Assisted Testing

Objectives

The objectives of this study were to develop, implement and evaluate the year long project, Microcomputer Adaptive Testing High-Risk Urban Students (MATH-R-US). The project produced diagnostic software to meet the following criteria: (a) help students obtain high school mathematics credit needed for graduation, (b) motivate students to learn mathematics, (c) account for erratic student attendance, and (d) use computer adaptive testing as an integral part of the program.

Theoretical Framework

The theoretical framework of this study was based on the literature concerning: (a) computer adaptive testing of computational skills, (b) assessment as part of instruction, and (c) computer assisted instruction/testing with high risk students. Computer adaptive testing has been recognized as an effective means of assessing student performance of computational skills (Attisha & Yazdani, 1983; Janke & Pilkey, 1985; McDonald, Beal & Ayers, 1987/1988; Signer, 1982; & Travis, 1984). The advantages of computer assisted testing include: (a) flexibility of administration time, (b) efficiency, (c) test security, (d) clerical processing power, and (e) reduction in test construction time (Lippey, 1973; Reckase, 1986; Signer, 1982).

Recommendations support the need for the continual integration of assessment into classroom instruction (Bright, 1988; Bunderson, Inouye & Olsen, 1988; Fisher, Berliner, Filbey, Marliave, Cahen and Dishaw, 1980; & The National Council of Teachers of Mathematics, 1989). Moreover, the use of diagnostic data by teachers has been positively correlated with student achievement (Bright, 1987; Lamon & Bright, 1987).

Evaluation studies of computer use in programs for students in danger of dropping out of high school are few (Polin, 1989). Guerrero and Swan (1988) investigated the efficacy of computer assisted instruction (CAI) with older, at-risk students in New York City. The researchers reported improvement in student attitudes and pride in their work. Johnson & Mihal (1973) found that black elementary students improved their performance with computerized tests. They hypothesized that anxiety increases when tests are administered by individuals representing more advantaged populations.

Project Description

The topics of the MATH-R-US diagnostic programs and accompanying practice sheets are: (a) numeration, (b) whole numbers, (c) fractions, (d) decimals, (e) percent , and (f) measurement. They were written to test every required high school general mathematics objective as described in the city's curriculum guide. The project was used for an entire school year by a class in an urban high school. The school serves an at-risk predominantly black population with a high rate of absenteeism.

The tests accept generative responses, rather than multiple choice answers. If a student's answer is correct, the next objective is tested. If an answer is incorrect, a second question on that objective is presented. If that too is incorrect, than that objective is considered missed. Upon completion of the test, results are shown on a computer monitor, saved on a disk for later retrieval, and reproduced by a printer. Practice sheets, with answer keys, can then generated for the missed objectives.

The diagnostic tests were administered once a week in the school's computer lab. During the other daily class meetings, students worked on the computer generated practice sheets. Students typically would be working on different objectives.

Methods

Evaluation was not conducted to fulfill external funding requirements. Instead, its purpose was to improve implementation and furnish descriptive data to the classroom teacher and school administrators. In this respect, evaluation was applied according to the definition of Stake (1967) which is to describe inputs, processes, and outcomes.

The program's author observed the computer sessions to record both teacher and student suggestions. Recommendations were incorporated into the programs and tested at the next weekly computer class. Weekly computer test results were kept by the teacher. For each student he noted when a test was taken, which objectives were missed, and the objective that was last attempted on the test. The teacher decided which tests to give to each student and whether or not they should be repeated. These records were used to assess the students' achievement in mathematics.

A graduate student attended all the computer sessions to record on and off task behaviors. To ascertain student attitude toward their instruction, an attitude survey was administered at the end of the year. The attitude instrument was based on the Attitude Toward Instructional Setting Survey developed by Suydam (1974). All items are scored on a five point Likert scale (strongly agree, agree, neutral, disagree and strongly disagree).

Data Source

The students were part of a special program in an urban high school serving predominantly black youth. They were targeted as the most at-risk of dropping out before high school graduation. They had a history of high absenteeism and academic setbacks.

Close to thirty students comprised the targeted group. However, the actual group member changed sharply throughout the year because of: (a) erratic attendance, (b) students dropping out of school, (c) students transferring to other schools, and (d) new students being admitted to the class. For this reason, it was not feasible to apply comparative testing procedures.

Results

One finding of the study was intense student generated competition. When students completed a test with 100% accuracy, a graphic of a hamburger appeared on the screen. The students turned this feature into a contest. Upon entering the computer lab, they raced to see who could get the most hamburgers in that hour. Another observation was the absence of off task behaviors. As a result of the student competition for hamburger pictures, students infrequently (less than 5% of observed computer class time) engaged in off task behavior.

An examination of the attitude data was conducted to look for aggregate responses and to determine if there were differences according to gender. Only students who attended at least two consecutive months of classes completed the survey. Fifteen students met this criteria. Although both males and females responded positively to the components surveyed overall, an inspection of the responses disclosed differences by gender. Results showed that the males tended to distribute their responses across the five responses, while the females clustered their responses at the extremes.

Means for each item were computed by gender. In order to compare the means for each statement, many of the survey items were reworded for positive phrasing. Mean scores ranging from 1 to 1.49 were interpreted to denote strongly agree; 1.50 to 2.49 agree; 2.50 to 3.49 undecided; 3.50 to 4.49 disagree; and 4.50 to 5.00 strongly disagree. Attitude survey responses that reflected personal concerns (fear of operating the computer, receiving attention, and opinion of the teacher) were more positive and stronger among the females. This was also true for items that described the classroom environment as conducive to learning. Table 1 contains a list of the attitude statements that were rated differently by the nine males and six females. While both males and females expressed positive attitudes about the course components, it is interesting that the female responses reflected more confidence in one's own abilities.

An observation that occurred with increasing frequency was student insistence that answers were correct, when the computer indicated otherwise. As a result, the students were very eager to prove themselves to their teacher. This observation was surprising since students, especially low achieving students, are not inclined to review examples they are told are incorrectly solved.

Achievement in mathematics was studied by examining student performance on the diagnostic tests during the year. The unstable student population demanded that this assessment look at individual student performance on repeated tests. The data in Table 5 reports test results for students who took the same topic test more than once. Only 17 of 48 students met this criterion. While many other students took several computer tests, they did not attend often enough to have engaged in the same test more than once.

An inspection of the computer math test scores indicated a consistent improvement on retesting of a topic, with a 25% average increase over an earlier test. Of the 43 retests, only 3 did not show an improvement. The 23 perfect scores are noteworthy, in light of the difficulty of many of the test items. Table 2 lists the more difficult objectives for the topic tests.

Educational Implications

This study supports the findings of Becker (1988) and Guerrero and Swan (1988). At-risk high school minority students can profit from computer assisted instruction with increased motivation, self-confidence, and self-discipline. Even though the students were being asked to solve 100% of the topic objectives with 100% accuracy (without guessing), they did not feel that too much work was required for the course.

It is noteworthy that the girls were more definitive and self-assured than the boys. Girls have historically been described as more computer anxious than boys. Nevertheless, unlike the boys, the girls were undivided in their agreement that they were confident they could operate the computer. They viewed the computer as having a positive effect on their learning and expressed a sense of active enjoyment. These results are considerably different from those of Campbell and Perry (1988). Their results found more minority stereotyping of computers as a male domain. The majority of students in the Campbell and Perry study had completed a computer course. In contrast, those in this study were at-risk students who used the computer as a tool rather than as the object of instruction. An explanation of the results of this project raises the possibility that older at-risk, black girls are not as computer anxious as girls have been reported.

The high risk black high school girls in this study seemed to exhibit higher self-confidence toward computers than that found in other studies that examined gender. Recognizing that generalizations from small samples are dangerous, the results of this investigation solely suggest that research is needed to investigate computer and mathematics anxiety of black teenage girls. Specificly, studies should examine the mathematics and computer anxiety of black, at-risk, high school girls, when the computer is used as a tool, rather than as the object of instruction.

Previous research has found a positive correlation of computer access and use with general school achievement (Becker (1987); Blaschke (1986); Gannon (1986); Krulik & Krulik (1987). More recently, the availability of computers in middle- and upper-income homes has exacerbated the school equity/access problem for the black at-risk student. In light of the results of this project and the equity issue, technology affirmative action seems necessary so that low achievers will have more opportunities, rather than fewer, to raise their levels of achievement.

References

Attisha, M. & Yazdani, M. (1984). An expert system for diagnosing children's multiplication errors. Instructional Science, 13, 79-92.

Becker, H.J. (1988). Higher computer access for high ability students. BYTE, 12,149-162.

Becker, H. J. (1987). The impact of computer use on children's learning: What research has shown and what it has not. Washington, DC: Paper presented at the Annual Meeting of the American Educational Research Association. (ERIC ED 287 458)

Blaschke, C. (1986). In Dey Hynson (Ed.), CAI effectiveness and advancing technologies: An update. Fairfax, VA: International Communications Industries Association.

Bright, G. (1987). Computers for diagnosis and prescription in mathematics. Focus on Learning Problems in Mathematics, 9, 29-41.

Bunderson, C.V., Inouye, D.K., & Olsen, L. (1988). The four generations of computerized educational measurement. Princeton, NJ: Educational Testing Service, .

Campbell, N.J. and Perry, K.M. (1988). Sex and ethnic group differences in high school students' computer attitudes and computer attributions. Stillwater, OK: Oklahoma State University, 1988). (ERIC Document Reproduction Service No. ED 307 859)

Fisher, C.W., Berliner, D.C., Filbey, N.N., Marliave, T., Cahen, L.S., & Dishaw, M.M. (1980). Teaching behaviors, academic learning time, and student achievement: an overview. In C. Denham & Lieberman (Eds), Time to Learn, (pp7-32). Washington DC: National Institute of Education.

Gannon, J. F. (1986). The Increasing effects of computers on education. (ERIC ED 286 498)

Guerrero, F. & Swan, K. (1988). Computer pilot program, 1986-87. New York, NY: New York City Board of Education, 1988. (ERIC Document Reproduction Service No. ED 301 155)

Janke, R. & Pilkey, P. (1985). Microcomputer diagnosis of whole number computational errors. Journal of Computers in Mathematics and Science Teaching, 5, 45-51.

Johnson, D. F., & Mihal, W.L. (1973). Performance of Blacks and Whites in computerized versus manual testing environments. American Psychologist, 28, 694-699.

Krulik, J. E. & Krulik, C. C. (1987). Computer-based instruction: What 200 Evaluations say. Atlanta GA: Paper presented at the Annual Convention of the Association for Educational Communications and Technology. (ERIC ED 285 521)

Lamon, W.E. & Bright, G.W. (1987). Computers as direct aids to students and to teachers. Focus on Learning Problems in Mathematics, 9(2), 1-3.

Lippey, G. (1973). The computer can support test construction in a variety of ways. Educational Technology, 13(3), 10-12.

McDonald, J., Beal, J, & Ayers, F. (1988). Computer administered testing: diagnosis of addition computational skills in children. Journal of Computers in Mathematics and Science Teaching, 7(1-2), 38-43.

National Council of Teachers of Mathematics (1988). The curriculum and evaluation standards for school mathematics. Reston, VA: National Council of Teachers of Mathematics.

Polin, L. (1989). Research windows. The Computing Teacher, 17(3), 5-7.

Reckase, M.D. (1986). Position paper on the potential use of computerized testing procedures for the national assessment of educational progress. Washington, DC: American College Testing Service. (ERIC ED 279 693)

Signer, B. (1982). Math Doctor, M.D. - Microcomputer adaptive diagnosis. The Computing Teacher, 10, 16-18.

Stake, R.E, (1967). The countenance of educational evaluation. Teachers College Record, 68, 523-540.

Travis, B. (1984). Computer diagnosis of algorithmic errors. In V. Hansen and Marilyn Zweng (Eds.) Computers in Mathematics Education 1984 Yearbook (pp 211-216). Reston, VA: National Council of Teachers of Mathematics.

Table 1

Varying Mean Responses to the Attitude Survey by Gender

ATTITUDE CATEGORY	ATTITUDE STATEMENT	MEAN RATING M	F
Computer Confidence	I was afraid I couldn't operate the computer.	D	SD
Computer Value	I feel the computer was a waste of time.	D	SD
	Using the computer was boring.	U	D
Confidence could do the work.	Too much work was required for this class.	D	SD
	The slow worker didn't have a chance in this class.	U	D
	If a student did not learn in this class, it was his/her own fault.	U	D
Feel Important	Using the computer made me feel that I am important.	U	D
Computer depersonalizes instruction.	No one paid any attention to me when we used the computer.	D	SD
Enjoyed Computer	Time seemed to fly when we used the computers.	U	A

SA = Strongly Agree; A = Agree; U = Undecided;
D = Disagree; SD = Strongly

Table 2

Descriptors of Difficult Test Items

TOPIC	OBJECTIVE
Numeration	Estimating the square root to nearest tenth
Fractions	Finding a fractional part in a word problem Adding unlike denominators Subtracting unlike denominators Dividing mixed numbers Solving ratio and proportion problems
Percent	Finding percent when the percent is a decimal Finding percent in a word problem Finding a number when the percent is known Finding percent of discount, given original and sale prices Finding the cost given the percent of discount
Measurement	Doing two-step conversions, within a system Applying knowledge of measurement to word problems

Title:

The Impact of Cooperative Group Composition on Student Performance and Attitudes During Interactive Videodisc Instruction

Author:

Ali Simsek

Abstract

This study examined the relative effects of homogeneous versus heterogeneous ability grouping on performance and attitudes of students working cooperatively during interactive videodisc instruction. After two cooperative training sessions, 80 fourth through sixth grade students, classified as high and low ability, were randomly assigned to treatments. Students completed a level II interactive videodisc science lesson, an achievement test and an attitude questionnaire. The amount of instructional time for each group was also recorded. Results revealed that homogeneous low ability groups scored significantly less than the other three groups, while the difference between achievement of high ability students in homogeneous and heterogeneous groups was not statistically significant. Homogeneous low ability groups consistently used more instructional time than the other groups, whereas homogeneous high ability groups used the least amount of time. Low ability students in heterogeneous groups had significantly better attitude scores than their high ability groupmates. Implications for the collaborative use of level II videodiscs are discussed.

The Impact of Cooperative Group Composition on Student Performance and Attitudes During Interactive Videodisc Instruction

Educators have systematically attempted to develop new techniques and technologies for providing effective instruction for all learners. Much of these efforts have resulted in individualized instruction that adjusts the instructional sequence to the cognitive and affective needs of each learner. However, the potential for individualized instruction may be limited due to the difficulties associated with identifying individual differences and translating them into instructional prescriptions.

Furthermore, individualized instruction has its own shortcomings. An important shortcoming is that individualization often implies isolation. Working alone for long periods may cause boredom, frustration, and anxiety. As a consequence of this sterile approach, students may think that learning is impersonal. Secondly, individualized instruction does not allow students to interact with and learn from each other because it limits students to the resources provided by the learning environment. Finally, individualistic use of emerging interactive technologies such as computers and videodiscs greatly increases design and utility costs. Financial implications are particularly obvious when instruction requires a work station for each learner (Hooper & Hannafin, 1991; Johnson & Johnson, 1986).

It seems that cooperative learning has the potential to overcome these limitations. Carlson and Falk (1989), for example, concluded that cooperative groups can successfully use interactive videodiscs and perform better than those working alone. Noell and Carnine (1989) indicated that cooperative videodisc learning may be more efficient than individualistic use of this technology. Atkins and Blissett (1989) reported that students in small groups spent much of their time for interacting with partners. Similar results have been reported for computer-based cooperative learning (Dalton, Hannafin, & Hooper, 1989; Johnson, Skon, & Johnson, 1980; King, 1989; Mevarech, Silber, & Fine, 1991). Moreover, comprehensive research reviews show that the benefits of cooperative learning are not limited to achievement effects. There is strong research evidence demonstrating the affective benefits of working in cooperative groups (Johnson & Johnson, 1989; Newmann & Thompson, 1987; Rysavy & Sales, 1991; Sharan, 1980; Slavin, 1991; Webb, 1988).

In addition to establishing the efficacy of cooperative learning for technology-based instruction, the researchers must identify factors which influence the effectiveness of learning in small groups. One of these factors is group composition with regard to student ability. Cooperative learning usually involves heterogeneous grouping. That is, groups are formed by combining students of disparate ability, gender, and ethnic background. However, there is considerable disagreement regarding the effects of heterogeneous grouping on performance and attitudes of students representing different abilities.

Advocates of heterogeneous grouping claim that there might be some important advantages to having students from different abilities work together on cooperative tasks. They argue that while high ability students benefit from providing explanations to partners, low ability students benefit from the increased opportunities for support and encouragement. The results of some experimental studies showed that students of all abilities benefitted from participating in a heterogeneous cooperative group compared to students of similar ability who worked alone (Dalton, Hannafin, & Hooper, 1989; Gabbert, Johnson, & Johnson, 1986; Hooper & Hannafin, 1988; Johnson, Johnson, Roy, & Zaidman, 1985; Johnson, Skon, & Johnson, 1980; Yager, Johnson, Johnson, & Snider, 1986).

Critics claim that heterogeneous grouping promotes personal gains at the expense of others. Hill (1982) indicated that the performance of high ability students on complex tasks may be detrimentally affected by medium and low ability students. Beane and Lemke (1971), however, found that high ability students benefitted more from heterogeneous grouping. Slavin (1983) suggested that heterogeneous grouping may offer few benefits to low ability students because they are simply given the correct answers and do not learn skills necessary to achieve when working alone. Goldman (1965), on the other hand, reported that students working with partners of higher abilities performed better than those working with partners of similar or lower abilities. Swing and Peterson (1982) found that peer interaction in mixed groups enhanced the achievement of high and low ability learners, but did not have any affect on the performance of medium ability students. Webb (1982) reached a similar conclusion that average students in homogeneous groups showed higher achievement and received more explanations than average students in heterogeneous groups.

In short, the results of cooperative learning studies which examined the effects of ability on student performance and attitudes are inconclusive. More research is needed to clarify this uncertainty. The present study attempted to extend these findings by determining whether interactive videodisc instruction can be completed as effectively in a mixed small group as in a uniform ability group.

More specifically, the following questions were addressed in this study: (1) What is the impact of heterogeneous and homogeneous ability grouping on achievement of students working cooperatively on a science task; (2) Does heterogeneous or homogeneous ability grouping influence differently the amount of time spent in a cooperative group; and (3) How do heterogeneous and homogeneous ability grouping affect student attitudes toward delivery system, subject matter, and group work.

Method

Subjects

A sample of 80 fourth through sixth grade students selected from a rural school district in Minnesota participated in the study. Of this total number, 36 (45%) were males and 44 (55%) were females. The sample included 20 (25%) fourth graders, 32 (40%) fifth graders, and 28 (35%) sixth graders. Equal number of subjects were randomly assigned to treatments; stratified for ability, gender, and ethnic background.

Materials

Lesson content. Subjects have completed a level II interactive videodisc lesson about whales. The basic lesson included four segments: (a) characteristics of whales; (b) kinds of whales; (c) behavior of whales; and (d) whales and people. Each lesson segment contained presentation sequences and relevant embedded questions. The lesson began by displaying a title screen with directions. Learners were then presented a main menu showing each of the four segments. Once a segment was chosen, students could not exit until that particular segment had been completed. However, learners could watch a segment as many times as they wished.

Pretest. Students' composite scores on the Iowa Test of Basic Skills were used for assigning them into high and low ability groups. The median score for the overall group was taken as the cut-off point. High ability students were defined as those with combined scores above the median, while students with combined scores below the median were defined as low ability. As a way of reducing the classification error, middle 10% of the students (those falling between 45th and 55th percentile) were not included.

Posttest. The achievement posttest contained 40 items divided among 10 true/false, 25 multiple-choice, and 5 matching questions. The KR-20 reliability coefficient for this test was .74, with an average item difficulty of .70. A typical item on the posttest was: "Mother whales feed or nurse their young with (a) shrimp, (b) milk in their bodies, (c) moss".

Attitude Questionnaire. This instrument measured students' reactions to cooperative learning. It included 27 Likert-type items divided equally among three categories: attitudes toward delivery system, attitudes toward subject matter, and attitudes toward group work. Possible responses ranged from "Strongly Agree" to "Strongly Disagree". The Coefficient Alpha reliability for the questionnaire was .82. A typical item on this instrument was: "I feel more comfortable working in a small group than working alone".

Procedures

Based upon their ability scores, students were randomly assigned to homogeneous and heterogeneous cooperative groups. Each heterogeneous group had two high and two low ability members, while each homogeneous group had four students of the same ability. Prior to the study, all subjects participated in two training sessions on cooperative learning. Students recorded the time before starting the lesson, and again upon completion. Following the instruction, they responded to an achievement posttest and an attitude questionnaire on individual basis. The entire experiment lasted about two hours for each student. Subjects were excused from their classes during the experiment and given a token reward for participating in the study.

Cooperation Training. The main purpose of this training activity was to help students become better cooperative learners on the study tasks. Two training sessions were conducted over two consecutive days. Participants completed several exercises emphasizing the basic principles of cooperative learning. First, the "Magic Triangle" exercise (Johnson, Johnson, & Holubec, 1991) required students to find the maximum number of embedded triangles in a big one. Some students completed this exercise in small groups, while the others worked individually. The result was overwhelmingly better success rate for those working together in small groups. This helped the students draw the conclusion that working together can be more effective than working alone. The students then collaborated in small teams to work on a rule-generation exercise for groups of similar figures. The rules to be generated ranged from fairly easy to very complex. Successful teams shared their answers and strategies with the whole class. The class discussion then focused on specific behaviors that were helpful (e.g. explaining) and not helpful (e.g. teasing).

The second day of training activities began with the "Broken Circles" exercise (Cohen, 1986). This game emphasized the importance of positive interdependence among members of a cooperative group. Each group was given pieces of broken circles. The task was to form at least one complete circle for each member of the group, but the students had to exchange pieces voluntarily without being asked. The students were also instructed not to talk and take others' pieces unless offered. This game forced the group members to pool and share their resources in accomplishing the mutual goal. The fourth exercise was about correcting some grammar errors in a short paragraph. Such an exercise provided the students with additional opportunities to practice cooperative skills on a school-related task. Finally, the students were asked to discuss the strengths and weaknesses of their group work by listing five advantages and disadvantages of working together.

Treatment. Students completed a level II interactive videodisc science lesson in small groups. Each tutorial-like presentation segment was followed by practice questions. Before responding to each question, the students discussed the options and attempted to reach a consensus about the answer. Following their response, they received feedback. When the answer was correct, they were presented affirmative feedback and progressed to the next item. If incorrect, however, the students were given a second chance. After two incorrect responses, the review of the relevant lesson segment was automatically provided. Group members watched the review and discussed it one more time. When they have completed a segment, the main menu was displayed and the group members selected the segment they wanted to study. Upon completion of the lesson, the students responded to the achievement posttest and the attitude questionnaire individually.

Design and Data Analysis

The study employed a 2 by 2 randomized block design. The first factor was the type of grouping (heterogeneous versus homogeneous), and the second ability (high versus low). The dependent variables were achievement, time on task, and attitudes toward instructional delivery system, subject matter, and team work.

Results

Achievement

Means and standard deviations for achievement scores are presented in Table 1. High ability students (M=30.13) performed better on the posttest than low ability students (M=25, 65). Also, the overall mean score for heterogeneous groups was slightly higher than the overall mean score for homogeneous groups (M=28.63 and M=27.15, respectively).

Table 1
Means and Standard Deviations for Posttest Scores

	Grouping		
Ability	Homogeneous	Heterogeneous	Total
High			
Mean:	30.45	29.80	30.13
SD:	2.61	3.02	2.80
N:	20	20	40
Low			
Mean:	23.85	27.45	25.65
SD:	5.15	3.79	4.82
N:	20	20	40
Combined			
Mean:	27.15	28.63	27.89
SD:	5.24	3.59	4.52
N:	40	40	80

Two-way ANOVA results yielded a significant main effect for student ability $F(1,76)=28.19$, $p<.001$. The main effect for type of grouping, on the other hand, was not significant $F(1,76)=3.06$, $p>.084$.

The interaction between ability and group composition was also significant F(1, 76)=6.36, p<.014. Figure 1 projects these results.

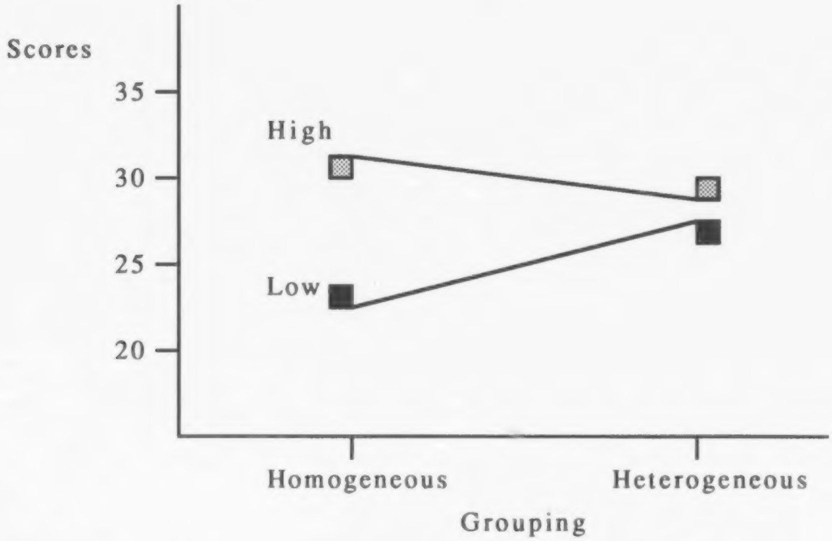


Figure 1. Interaction Between Ability and Group Composition on Posttest Scores

One-way ANOVA results revealed that the difference between the achievement of high ability students in either groups was not significant F(1,38)=0.53, p>.471. However, the difference between the achievement of low ability students was significant in favor of heterogeneous grouping F(1,38)=6.33, p<.016.

Time on Task

Means and standard deviations for time on-task are shown in Table 2. High ability students used less less time (M=33.80) than low ability students (M=40.60). The overall mean for heterogeneous groups was smaller than the overall mean for homogeneous groups (M=34.60 and M=39.80, respectively).

Table 2
Means and Standard Deviations for Instructional Time

	Grouping		
Ability	Homogeneous	Heterogeneous	Total
High			
Mean:	33.00	34.60	33.80
SD:	6.05	4.59	5.37
N:	20	20	40
Low			
Mean:	46.60	34.60	40.60
SD:	1.90	4.59	7.00
N:	20	20	40
Combined			
Mean:	39.80	34.60	37.20
SD:	8.19	3.53	7.08
N:	40	40	80

Two-way ANOVA results yielded a significant main effect for both ability $F(1.76)= 44.87$, $p<000$ and type of grouping $F(1.76)=26.24$, $p<001$. The interaction effect was also significant $F(1,76)=44.87$, $p<000$. Figure 2 shows these relationships.

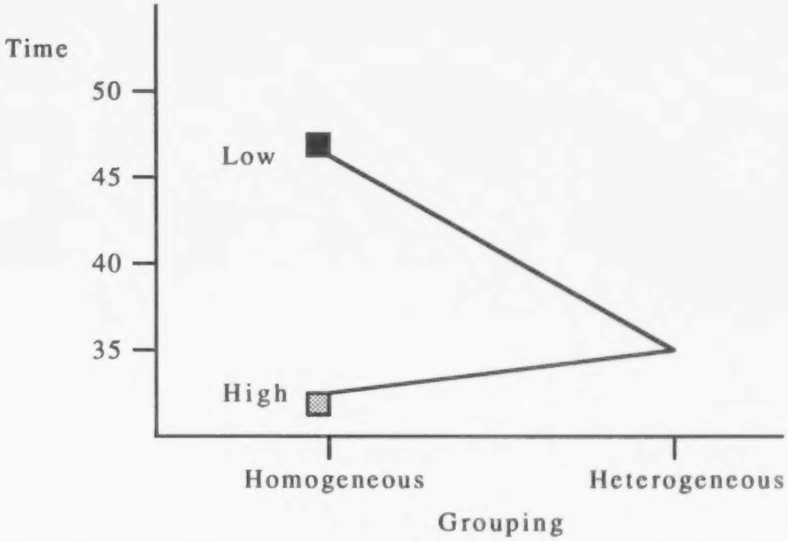


Figure 2. Interaction Between Ability and Group Composition on Instructional Time

One-way ANOVA results for the follow-up comparisons revealed that the difference in the amount of instructional time for high ability students in either groups was not significant $F(1,38)=0.89$, $p>.352$. On the other hand, the difference between low ability students was significant, suggesting the efficiency of heterogeneous grouping $F(1,38)=116.52$, $p<.001$.

Attitudes

Means and standard deviations for attitude scores are reported in Table 3. Overall, the mean attitude score for low ability students was higher (M=88.47) than the mean attitude score for high ability students (M=85.03). Similarly, heterogeneous ability grouping resulted in higher mean attitude score than homogeneous grouping (M=87.30 and M=86.20, respectively).

Table 3
Means and Standard Deviations for Attitude Scores

	Grouping		
Ability	Homogeneous	Heterogeneous	Total
High			
Mean:	87.30	82.75	85.03
SD:	9.54	12.78	11.37
N:	20	20	40
Low			
Mean:	85.10	91.85	88.47
SD:	9.94	10.96	10.88
N:	20	20	40
Combined			
Mean:	86.20	87.30	86.75
SD:	9.68	12.62	11.19
N:	40	40	80

Two-way ANOVA results yielded no significant main effect for ability $F(1.76)=2.01$, $p>.160$ and type of grouping $F(1,76)=0.20$, $p>.652$. However, the interaction effect was significant $F(1,76)=5.40$, $p<.022$. We also tested whether there was a significant difference between subcategories of the questionnaire. Neither the main effect for subcategories $F(1,76)=1.37$, $p>.256$, nor the interaction effects $F(1,76)=0.50$, $p>.610$ (ability by subcategory); $F(1.76)=0.98$, $p>.376$ (grouping by subcategory); and $F(1,76)=2.34$, $p>.099$ (ability by grouping by subcategory) were significant. This situation is reflected in Figure 3.

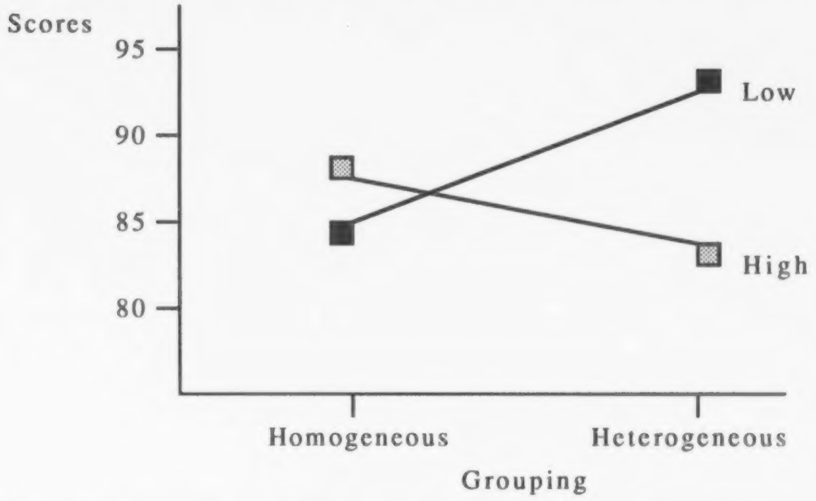


Figure 3. Interaction Between Ability and Group Composition on Attitude Scores

One-way ANOVA results for follow-up comparisons revealed that the difference between the mean attitude score for high ability students in either groups was not significant $F(1,38)=1.89$, $p>.177$. On the other hand, the difference between the mean attitude score for low ability students was significant in favor of heterogeneous grouping $F(1,38)= 5.66$, $p<.022$.

Discussion

This study examined the effects of homogeneous versus heterogeneous ability grouping on student performance, time on task, and attitudes toward delivery system, subject matter, and group work during interactive videodisc instruction in elementary science. At the end of the lesson, the students completed a posttest and an attitude questionnaire.

Results of the study showed that heterogeneous ability grouping was not detrimental for achievement, regardless of students' ability levels. There was no significant difference in the performance of high-ability students in either groups. However, homogeneous ability grouping was detrimental for the achievement of low-ability students. This is consistent with the findings of some other studies (Goldman, 1965; Hooper & Hannafin, 1988; Johnson & Johnson, 1989; Swing & Peterson, 1982; Webb, 1982). One possible explanation for this result would be that homogeneously grouped low ability students may not be capable of supporting each other's learning needs. They may also perceive their partners as not being able to find and explain better solution proposals to the difficulties of the group. On the other hand, high-ability students in homogeneous groups may overestimate each other's intellectual power. As Webb (1988) suggests, they may mistakenly assume that everyone in the group understands the task and therefore may interact less efficiently. Future research should test the validity of these speculations by comparing peer interaction within homogeneous groups.

Although homogeneous high ability groups spent less instructional time than heterogeneous groups, the difference was not statistically significant. However, low ability homogeneous groups consistently used more time on task than heterogeneous groups. This, in general, supports the notion that heterogeneous groups are more efficient for less-able students than homogeneous groups (Hooper & Hannafin, 1988; Webb

& Cullian, 1983). The reason might be that members of heterogeneous ability groups show higher understanding and employ better learning strategies in accomplishing the mutual task. As a result of interacting with their more-able partners in heterogeneous groups, low-ability students may acquire better problem solving skills. The use of more efficient strategies can accelerate slow learners in heterogeneous groups and reduce the time on task. On the other hand, homogeneous low ability groups cannot take advantage of diversity which helps them avoid typical mistakes and save time.

The results of the present study also demonstrated that heterogeneous ability grouping generates more positive attitudes toward instructional delivery system, subject matter, and team work than homogeneous grouping. The difference is particularly noticeable for low ability students in mixed groups, without an accompanying decrement for their high-ability groupmates. Homogeneous low ability groups reported the lowest attitude scores than the other three groups, but the difference between high ability students in either groups was not significant. This agrees with the findings of previous research (Hooper & Hannafin, 1991; Johnson, Johnson, & Maruyama, 1983; Webb, 1983). Perhaps, low-ability students in heterogeneous groups feel more supported and satisfied than other students. They may also feel privileged because their high ability groupmates are always available to help them. This special care, encouragement, liking, and mutual trust in heterogeneous groups may promote better social relationships among group members.

Conclusion

Although emerging interactive technologies are gradually taking place in schools, educators are still facing a serious dilemma. They are either to find more effective ways of using these technologies in the classroom or to limit the access by large groups of students. Interactive videodisc is no exception. Fortunately, however, new methods are being successfully developed for the effective use of interactive videodisc systems. Cooperative learning is one of them.

In general, advocates of cooperative learning recommend that students be grouped heterogeneously. However, the benefits of heterogeneous grouping have not been clearly established. Some claim that heterogeneous ability grouping supports the needs of one group at the expense of another. There is also substantial evidence suggesting that heterogeneous grouping is effective for all students. The results of this study supports the latter view. That is, heterogeneous grouping is more effective and efficient than homogeneous grouping. Thus, instructional designers and classroom teachers should consider using heterogeneous groups when designing cooperative videodisc environments.

It is a fact that homogeneous grouping is still a common practice in public schools. Unfortunately, educators tend to continue this trend. Therefore, future research should focus on developing more effective interventions within homogeneous learning groups. One of the potential variables that should be investigated further is the impact of exercising learner control during cooperative group work. Future research should also examine the effects of manipulating group size.

References

Atkins, M. & Blissett, G. (1989). Learning activities and interactive videodiscs: An exploratory study. British Journal of Educational Technology, 20(1), 47-56.

Carlson, H. L. & Falk, D. R. (1989). Effective use of interactive videodisc instruction in understanding and implementing cooperative group learning with elementary pupils in social studies and social education. Theory and Research in Social Education, 17(3), 241-258.

Cohen, E. G. (1986). Designing groupwork: Strategies for heterogeneous classroom. New York: Teacher College Press.

Dalton, D. W., Hannafin, M. J., & Hooper, S. (1989). Effects of individual and cooperative computer-assisted instruction on student performance and attitudes. Educational Technology Research and Development, 37(2), 15-24.

Gabbert, B., Johnson, D. W., & Johnson, R. T. (1986). Cooperative learning, group-to-individual transfer, process gain, and the acquisition of cognitive reasoning strategies. The Journal of Psychology, 120(3), 265-278.

Goldman, M. (1965). A comparison of individual and group performance for varying combinations of initial ability. Journal of Personality and Social Psychology, 1(3), 210-216.

Hill, G. (1982). Group versus individual performance: Are N+1 heads better than one? Psychological Bulletin, 91, 517-539.

Hooper, S. & Hannafin, M. J. (1988). Cooperative CBI: The effects of heterogeneous versus homogeneous grouping on the learning of progressively complex concepts. Journal of Educational Computing Research, 4(4), 413-424.

Hooper, S. & Hannafin, M. J. (1991). The effects of group composition on achievement, interaction, and learning efficiency during computer-based cooperative instruction. Educational Technology Research and Development, 39(3), 27-40.

Johnson, D. W. & Johnson, R. T. (1986). Computer-assisted cooperative learning. Educational Technology, 26(2), 12-18.

Johnson, D. W. & Johnson, R. T. (1989). Cooperation and competition: Theory and research. Edina, MN: Interaction Book Company.

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (1991). Cooperation in the classroom. Edina, MN: Interaction Book Company.

Johnson, D. W., Johnson, R. T., & Maruyama, G. (1983). Interdependence and interpersonal attraction among heterogeneous and homogeneous individuals. Review of Educational Research, 53, 5-54.

Johnson, D. W., Johnson, R. T., Roy, P., & Zaidman, B. (1985). Oral interaction in cooperative learning groups: Speaking, listening, and the nature of statements made by high-, medium, and low achieving students. The Journal of Psychology, 119(4), 303-321.

Johnson, D. W., Skon, L., & Johnson, R. T. (1980). Effects of cooperative, competitive, and individualistic conditions on children's problem solving performance. American Educational Research Journal, 17(1), 83-93.

King, A. (1989). Verbal interaction and problem solving within computer-assisted cooperative learning groups. Journal of Educational Computing Research, 5(1), 1-15.

Mevarech, Z. R., Silber, O., & Fine, D. (1991). Learning with computer in small groups: Cognitive and affective outcomes. Journal of Educational Computing Research, 7(2), 233-243.

Newmann, F. M. & Thompson, J. A. (1987). Effects of cooperative learning on achievement in secondary schools: A summary of research. University of Wisconsin-Madison, The Center on Effective Secondary Schools.

Noell, J. & Carnine, D. (1989). Group and individual computer-based video instruction. Educational Technology, 29 (1), 36-37.

Rysavy, D. M. & Sales, G. C. (1991). Cooperative learning in computer-based instruction. Educational Technology Research and Development, 39(2), 70-79.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement, attitudes, and ethnic relations. Review of Educational Research, 50(3), 241-271.

Slavin, R. E. (1983). When does cooperative learning increase student achievement? Psychological Bulletin, 94(3), 429-445.

Slavin, R. E. (1991). Synthesis of research on cooperative learning. Educational Leadership, 47(4), 52-54.

Swing, S. R. & Peterson, P. L. (1982). The relationship of student ability and small group interaction to student achievement. American Educational Research Journal, 19(2), 259-274.

Webb, N. M. (1982). Group composition, group interaction, and achievement in cooperative small groups. Journal of Educational Psychology, 74(4), 475-484.

Webb, N. M. (1983). Predicting learning from student interaction: Defining the interaction variables. Educational Psychologist, 18(1), 33-41.

Webb, N. M. & Cullian, L. K. (1983). Group interaction and achievement in small groups: Stability over time. American Educational Research Journal, 20(3), 411-423.

Webb, N. M. (1988). Peer interaction and learning with computers in small groups. Computers in Human Behavior, 3, 193-209.

Yager, S., Johnson, D. W., Johnson, R. T., & Snider, B. (1986). The impact of group processing on achievement in cooperative learning groups. The Journal of Social Psychology, 126(3), 389-397.

Title:

The Effects of Knowledge of Results Feedback of Captioning on Listening Comprehension of English as a Second Language in Interactive Videodisc System

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Abstract

The effects of English captioning used as knowledge of results feedback during English listening comprehension practice for Taiwanese students were investigated. Seventy-two college freshmen at National Taiwan Normal University participated in the study, using an interactive videodisc program one hour every two weeks over ten weeks. Two versions of the program, one with captioning and one without, were used. The effects on listening comprehension were measured by both a treatment content specific listening comprehension test and the listening comprehension sub-test of the Test of English as a Foreign Language (TOEFL). The results indicate that subjects in the captioning treatment had a significantly higher score on the treatment content specific listening comprehension test. There was no significant difference between the groups on the TOEFL listening comprehension test which measures general comprehension skills. In addition, English reading ability did have a significant impact on listening comprehension performance with those subjects in the above average group preforming better than those in the below average group. These results suggest that using captioning for specific content will improve the learners comprehension within that content. It is possible that exposing students to a wide variety of content areas using captioning may have a positive impact on general listening comprehension skills.

While many Taiwanese students have studied English for at least seven years, they still cannot readily understand movies, TV programs, or class lectures. In addition, many students who take the TOEFL (Test of English as a Foreign Language) receive a low score on the listening comprehension part of the test. This may be because they have English reading and grammar classes but no listening classes in high school, college, or university. Furthermore, many teachers still use the traditional grammar-translation method to teach English. Thus, many students are unable to effectively communicate with native speakers.

Both language teachers and students in Taiwan tend to neglect the importance of listening comprehension skills. They do so because they focus on a final goal of reading. They fail to realize the necessity for developing listening comprehension skills as a prerequisite to developing speaking skills. This basic orientation is reflected in the often-heard question, "Do you speak English?" Obviously, one cannot speak a language unless one can understand it (Chastain, 1988).

Although listening comprehension is of primary importance in second language acquisition (Krasen & Terrell, 1983; Krasen, Terrell, Ehrman, and Herzog, 1984), many contemporary foreign language educators have neglected its importance (Krasen et al., 1984; Paulston & Brunder, 1976; Rivers, 1981). This neglect may stem from the fact that listening is considered a receptive or passive skill and from the belief that merely exposing the student to the spoken language is adequate instruction in listening comprehension (Call, 1985). However, foreign language learners must know the language rules before they can produce language, "competence must precede performance" (Chastain, 1988, p. 91). Thus, Chastain emphasizes that "comprehension activities, such as those students perform in listening and reading, must precede productive activities, that is, speaking and writing" (p. 92). In other words, listening and reading, the receptive skills, are methods for developing and expanding competence.

Postovsky (1974) found that pronunciation of Russian is better when learners are encouraged to listen and not speak during the early stages of instruction. Morley (1985) also proposed that students should not be asked to produce language before they possess enough knowledge to make production possible. In other words, foreign language learners should learn to listen and comprehend first, then speak. That is because early listening instruction allows learners to internalize representations of sound, providing a better basis for producing and evaluating their own speech production (Carroll, 1986).

Listening comprehension is characterized as a highly-complex, problem-solving activity that can be broken down into a set of subskills (Byrnes, 1984). Two of these skills are described by Rivers (1971) as the recognition of component parts of the language (words, phrases, and clauses) and the memorization of these elements. Recognizing linguistic elements is not sufficient for comprehending what is heard. Listeners must be able to retain these elements in short-term memory long enough to interpret what the elements mean (Call, 1985). In fact, for language learners, understanding the spoken word poses more obstacles than speaking, because in generating speech, learners can control the scope and difficulty of words and expressions. Listeners, however, encounter and decode unfamiliar messages (Wipf, 1984).

Rivers and Temperley (1978) suggest that short-term memory for foreign language words is often overloaded, causing words to be purged before they can be organized and interpreted. Thus, even though second language learners may be able to recognize each word the speakers said, they may not remember lengthy utterances long enough to interpret them. Therefore, this study used short clips in order to allow the learners to process information.

One of the most difficult problems students have in developing listening comprehension is fear (Chastain, 1988). They are afraid that they will be unable to catch every word that the speaker says. They are also concerned that they may not be able to answer the teacher's questions if they do not comprehend every word and every sound.

Ur (1984) argues that there are some other major problems: (1) Foreign language learners do not perceive certain English sounds because these do not exist at all in their native language. For example, Chinese students have difficulty pronouncing and distinguishing the difference between /r/ and /l/ sounds. (2) The English systems of intonation, stress, and rhythm can interfere with the foreign learner's understanding of spoken English. For example, a falling tone on "Pardon me" means "Excuse me", while a rising tone means "Would you please repeat what you said?". (3) Prediction is difficult for the foreign-language learner. If he/she can guess what is going to be said next, he/she will be much more likely to understand it well. (4) While it is obvious that a learner would probably not understand a word he/she has not learned yet, the learner also needs to know that certain expressions are common in colloquial English, but taboo in formal style. (5) If a native speaker knows what he/she is going to say next, his/her utterances are often delivered at a tremendous rate. The foreign language learner simply does not have the time to search long-term memory for their meaning. (6) Many learners who are used to the accent of their own teachers or friends are frustrated when they find they have difficulty understanding someone else's accent. For example, some learners can't understand the British English accent, or the southern accent of the United States of America.

Donaldson-Evans (1981) maintains that there are two other common causes that hinder comprehension. First, second language learners lack a sufficient amount of cultural and linguistic knowledge.

Speakers and listeners do not have to share identical backgrounds, but the listener must share enough knowledge to permit comprehension of the speaker's message. Second, the listener does not know a large quantity of vocabulary. Listeners do not have to know the meaning of every word, since vocabulary and idiomatic expressions are the key to comprehension. They comprehend better if they can recognize enough words to establish a context for making rational guesses.

One way to overcome some of these problems might be the presentation of verbatim "captions" and visual cues along with the aural information to be understood. The National Captioning Institute (NCI) points out that "many viewers without hearing impairments find ordinary subtitles ... distracting" (Farrel, 1984). Yet, Education Week (1990) and Price (1983) report that students who are learning English as a second language can significantly improve their language skills by watching closed-captioned television programs. They conclude that "the viewers of closed-captioned TV are better able to understand word meaning and pronunciation, recognize spellings and grasp concepts much more quickly than by reading alone" (Educational Week, 1990, p. 10). There has been little systematic research examining the feedback effect of captions on the learning of foreign languages in interactive videodisc systems. Little is known about how normal hearing viewers learn from captioned material. It is only as we understand more completely the learning process of second-language learners that we can more appropriately design and adapt instruction to meet their needs.

Along with the cues captioning may provide, movies can provide the body language, expression, and contextual cues difficult for teachers to duplicate within foreign language classrooms. Chastain (1988) argues that movies and plays are excellent sources of listening comprehension materials when the teacher can choose appropriate content for use in class. This is important because in Taiwan there is a lack of qualified teachers or experienced native speakers to teach listening comprehension of English as a second language.

Schneider and Bennion (1983) maintain that videodisc-based materials can provide highly motivating course segments for second language learning and fit in well with modern theories of language acquisition. Many studies have indicated that the interactive videodisc is an effective medium for improving listening skills (Javetz, 1986; Kim, 1987; Larson, 1984; Schitai, 1989; Tighe & Zufelt, 1988; Wyatt, 1984), because the interactive video allows students to listen and observe the speaker's body language, facial expressions, and contextual environment. It allows the students to control the program in order to meet their pace and to replay any unclear message immediately. Moreover, interactive videodisc is a cost-effective medium (Fletcher, 1989; West, 1989).

Interactive video allows a teacher to create an environment beneficial to learning in a variety of areas (Sherwood, Kinzer, Hasselbring, Bransford, Williams, & Goin, 1987). Many people have repurposed current popular feature films on videodisc to develop instruction. Allen (1986) maintains that a repurposed film or video contains two types of components that are not present in the original: (1) algorithms that bring the video under the control of the instructional system or the user; (2) additional messages, such as computer text and graphic displays that provide supplementary content.

These programs are based on three theoretical principles: (1) the importance of a contextually rich learning environment; (2) the use of instructional media to direct students' activities; and (3) the development of conceptual tools that students might use and transfer to a variety of settings (Sherwood et al., 1987). They add that there are several advantages in adapting videodisc-based movies for instruction: (1) the availability of material without the production expense and time delay of producing original video; (2) the high production quality of these movies; (3) the "naturally" occurring problem situations found in the movies, and (4) the motivational aspects of popular movies.

The characteristic of interactive video important for this study is the ability to add computer generated messages to the contextually rich environment provided by the video. This ability allows the system to provide very specific feedback about the correctness of the learner's interpretation of the spoken English from the film. This type of feedback is known as knowledge of results (KR) feedback.

Feedback is an important design feature in any instruction. In the nine events of instruction model, Gagne, Briggs, and Wager (1988) emphasize that it is essential to provide information to the learners about the correctness of their performance. However, feedback is the least understood instructional strategy (Cohen, 1985). Results of feedback studies are contradictory. For example, Kulik and Kulik (1988) conducted a meta-analysis on feedback timing and verbal learning and found that immediate feedback is more effective than delayed feedback in actual classroom quizzes and real learning materials. However, "experimental studies of acquisition of test content have usually produced the opposite result" (Kulik and Kulik, 1988, p. 79).

Knowledge of results feedback (KR) is an important source of information for skill learning, although it is not always a necessary condition (Swinnen, Vandenberghe, & Van Assche, 1986). Swinnen et al (1990) argue that knowledge of results feedback generates guidance-like effects from feedback during practice. They also maintain that "KR has a strong informational capability to guide or direct performance when it is present, helping the learner to maintain performance at or near the target" (p. 715). Moreover, Cohen (1985) states that KR allows the learner to confirm the accuracy of their responses in comprehending and mastering the material. In addition, "it may be necessary to confirm every correct response with KR so that a student feels comfortable with his or her mastery of the material" (p. 35).

However, Cohen (1985) indicates that feedback messages that are too long and time-consuming can slow down the pace of instruction and cause a confident student to feel impatient and frustrated. Swinnen et al. (1990) hold the same point of view. They argue that "KR may at the same time produce certain negative "side effects" that interfere in various ways with longer-term learning such as would be required for performance on a test of retention or transfer" (p. 715). They describe the negative effects as: (1) In simpler tasks, frequent KR encourages the learner to change behavior frequently in an attempt to eliminate errors. Some of the error corrections are very small and they may prevent or reduce the learning. (2) Frequent KR or instant KR can reduce the learning of error-detection capability because there is no time for learners to think about feedback.

One way to overcome the possible negative effects of long KR feedback is to provide visual messages that represent the English as verbatim text, along with repeating the audio. By designing the instruction with short passages, phrases and sentences the length of feedback remains short. Captioning is a good example of the exact order of verbatim that reproduces the words exactly as they are spoken in the movies or in television programs. Because of the limited capacity of short-term memory, the captioning in this study was designed as a short sentence.

In this study, captioning was designed as a function of knowledge of results feedback (KR) which serves as information to the learner that enhances goal attainment (Mayer, 1987; Salmoni, Schmidt, & Walter, 1984; Swinnen, Schmidt, Nicholson, & Shapiro (1990). Learners were encouraged to actively interpret captioning in order to improve listening comprehension. Very little investigation has been conducted on the effect of captioning as knowledge of results feedback.

STATEMENT OF THE PROBLEM

The purpose of this study was to investigate the effect of captioning as knowledge of results feedback on listening comprehension of English as a second language in a computer-based interactive videodisc system. The research questions investigated in this study were:

1. What was the effect of captioning used as knowledge of results feedback on listening comprehension of English as a second language as measured by a listening comprehension test using the

movie The Last Emperor and the TOEFL Listening Comprehension test?

2. Did above average reading proficiency students have higher achievement on a listening comprehension test using the movie The Last Emperor and the TOEFL Listening Comprehension test than below average English reading proficiency students?

3. Was there a statistically significant interaction between treatment and English reading proficiency for performance on a listening comprehension test using the movie The Last Emperor and the TOEFL Listening Comprehension test?

METHOD

Sample

Seventy-two freshmen at National Taiwan Normal University, Taipei, Taiwan, the Republic of China, sixty-one female and eleven male, participated in this study. The average age was 19 years. All subjects were enrolled in the mandatory Freshmen English course. The freshmen population was 1035. Of this population, all English majors and industrial education majors were excluded leaving 955 freshmen. Industrial education majors were not involved in the study because they did not take the Joint College Entranced Examination. Because captioning has a close relationship with reading ability, the subjects of this study were assigned to above or below reading proficiency groups according to their English scores on the Joint College Entrance Examination. The mean and standard deviation for English Achievement on the Joint College Entrance Examination were 58.48 and 13.14 respectively. This left 296 students above and 296 below. Thirty-six above and thirty-six below average English reading proficiency students were randomly selected and randomly assigned to one of two treatment groups so that eighteen high and eighteen low subjects were in each treatment group.

Materials

Two versions of an interactive videodisc program designed around the movie The Last Emperor were developed. One version, the captioning treatment, used captioning as knowledge of results feedback. The second version, the no captioning treatment, received no captioning as part of the feedback. There were no other differences between versions. The Last Emperor was chosen in part because it contains both content and bountiful dialogue that can be used for learning vocabulary, idiomatic expressions, and language comprehension. Most of the students knew the general history of The

Last Emperor, providing some relevance. In addition, the movie included anecdotes used to increase the entertainment effect which were not familiar to the students.

Lesson Description

Once the students booted the computer and initialized the videodisc player, a title screen was presented, then the system would ask the students to type in their student number. The system then confirmed whether he/she was a subject and in which treatment group she/he belonged. If he/she was not a subject then the system would exit. If he/she was a subject then the objectives and directions would be presented in English.

In the captioning treatment group, students watched a complete chapter of The Last Emperor. Then they viewed a series of clips, answering embedded questions about each clip. The embedded questions in the chapter were multiple-choice questions, designed using the same format as the Listening Comprehension subtest of TOEFL. (The TOFEL format consists of spoken statements, short conversations, and several short talks or presentations.) Students were encouraged to comprehend the ideas, the gist, rather than every word. Students were asked to answer using the contextual cues.

If they answered correctly, they reviewed the clip again with captioning used as a knowledge of results feedback to confirm every correct response. The program then branched the students to the next clip. If they answered incorrectly, they reviewed the clip one more time and were asked to answer the question again. If they still answered incorrectly, the captioning was displayed on the monitor, revealing the correct answer. Captioning served as information for the learners to interpret. Learners had only two tries per question and then they continued to the next clip. After completing each chapter, students received a summary display concerning their performance. The system then displayed the menu indicating the previous chapter(s), the next chapter, and quit option. Only those students who were 90% correct on the first try could continue with the next chapter.

In the no captioning treatment group, students received the same videodisc-based program without captioning in the feedback. If they answered a question correctly, they received the positive feedback, but without captions. If they answered incorrectly, they received negative feedback, and viewed that clip one more time and were asked to answer the question again. If they still answered incorrectly, the answer was displayed on the monitor without captioning. There were no other differences between the treatments.

The criterion of 90% correct on the first try was selected to ensure that students had mastered the material before proceeding to the next chapter. Bloom (1976) argues that mastery learning can be used as a way of eliminating individual differences among students in their ability to learn. Hence, in this study, all of the subjects would have the same mastery level before they took the post-test. If there was a significant difference between the groups, it was because of the treatment effect or the different reading proficiency level.

Procedure

Prior to receiving the treatments, all subjects were given the TOEFL Listening Comprehension subtest, used as a pretest. Then the two treatment groups used The Last Emperor one hour a week in alternating weeks for ten weeks. The captioning group practiced the first week and the no captioning group followed the second week. Most subjects were able to practice the entire program in the 5 hours' time limit. Some subjects had to repeat the same chapter if they were not 90% correct on the first try. At the end of twelve weeks, all subjects took the post-tests: the movie test and a second, equivalent form of the TOEFL Listening Comprehension subtest.

Instruments

The instruments used in this study were a listening test based on the movie The Last Emperor and two equivalent forms of the TOEFL Listening Comprehension test of the Educational Testing Service. They were administered to investigate the knowledge of results effect of captioning on above or below average English reading proficiency using a computer-based interactive videodisc system.

Validity and Reliability of the Movie Test

The test based on the movie The Last Emperor was constructed using the same format and with the same number of questions as the TOEFL Listening Comprehension subtest: fifty multiple-choice questions administered in thirty-five minutes. In addition, none of the questions in the movie test were the same as the embedded questions in the treatments. The test was recorded from the videodisc program of The Last Emperor using audio only, and consisted of spoken statements, short conversations, and several short talks.

In order to decide if the test items were appropriate, two American graduate students and one Chinese professor who teaches listening comprehension of English as a second language conducted an item analysis of the movie test. The following Likert-type scale was used: (1) Very Inappropriate, (2) Inappropriate, (3) Undecided, (4) Appropriate, and (5) Very Appropriate. Only test items scored on or above the Appropriate level by all three raters were used. A split-half reliability of the movie test was conducted, using the Spearman-Brown formula to estimate the reliability of the whole test. The split-half reliability coefficient of the movie test was .71.

Statistical Design

This study was a pretest-posttest control group design (Campbell & Stanley, 1963). The dependant variable, listening comprehension, was analyzed with a 2x2 (treatment x reading proficiency) analysis of covariance (ANCOVA) to test the following research hypotheses:

1. Students in the captioning as knowledge of results feedback treatment have significantly higher posttest mean scores on the movie test than students in the no captioning treatment.
2. Above average English reading proficiency students have significantly higher posttest mean scores on the movie test than below average English reading proficiency students after completing the treatments.
3. There is a significant interaction between treatment and reading proficiency for posttest mean scores on the test of movie The Last Emperor.
4. Students in the captioning as knowledge of results feedback treatment have significantly higher posttest mean scores on the TOEFL Listening Comprehension subtest than students in the no captioning treatment.
5. Above average English reading proficiency students have statistically higher posttest mean scores on the TOEFL Listening Comprehension subtest than below average English reading proficiency students after completing the treatments.
6. There is a significant interaction between treatment and reading proficiency for posttest mean scores on the TOEFL Listening Comprehension subtest.

Analysis of covariance reduces the effects of initial group differences statistically by making adjustments to post-test scores. The TOEFL pretest score was used as the covariate to adjust for both post-test scores.

Results

Each individual used the interactive videodisc program for five hours over ten weeks. The program consisted of seven chapters. Chapters one, two, three, and six took an average of 50 minutes to complete. Chapters four, five, and seven took an average of 30 minutes to complete. Because of the subjects' tight class schedules, the study was conducted in the evening and at noon, even on Saturday and Sunday. All subjects completed the first six chapters. Two subjects of below average reading proficiency in the captioning group completed all of seven chapters.

All hypotheses were tested at the a = 0.05 level of significance. The analysis of covariance (ANCOVA) was employed to evaluate the strength of the treatment based on the movie test of The Last Emperor and listening comprehension scores of TOEFL, using the pre-test performance scores of the TOEFL Listening Comprehension test as the covariate. The results of the pretest and both posttests are shown in Table 1.

Insert Table 1 about here

Hypotheses Testing Related to the Movie Test

The first analysis of covariance was used to determine the effects of the treatment and reading proficiency on performance on the movie test of The Last Emperor. The dependent variable, listening comprehension, was analyzed with a 2x2 (Treatment x Level of Reading Proficiency) analysis of covariance. The pretest of the movie test was used as covariate to adjust for post-test score.

The interaction of treatment and reading proficiency was analyzed to determine if high or low reading proficiency students differed with or without captioning on the movie test. As shown in Table 2, there was no interaction between treatment and reading proficiency, $F(1, 67) = 2.16$, $p = .15$ ($> .05$).

Insert Table 2 about here

Since there was no interaction, the main effects of treatment and reading proficiency were examined. Table 2 indicates that there was a statistically significant difference between groups due to the treatment, $F(1, 67) = 144.21$, $p < .01$ ($a < .05$). Subjects who received the captioning treatment had higher posttest mean scores on the movie test.

Table 2 also shows that there was a statistically significant difference between the above average English reading proficiency group and the below average English reading proficiency group on the movie test, $F(1, 67) = 34.25$, $p < .01$ ($a < .05$). Students in the above average reading proficiency group performed significantly better on the movie test.

Hypotheses Testing Related to the TOEFL Listening Comprehension Test

The second analysis of covariance was used to measure the effects of the treatment and reading proficiency on performance on the TOEFL Listening Comprehension test. The dependent variable, listening comprehension, was analyzed with a 2x2 (Treatment x Level of Reading Proficiency) analysis of covariance. TOEFL pre-test was used as covariate to adjust for post-test score.

Insert Table 3 about here

As in the case of the movie test, Table 3 shows that there was no interaction between treatment and reading proficiency, $\underline{F}(1, 67) = 1.43$, $\underline{p} = .24$ (> .05). Table 3 also indicates that the main effect of the treatment was not statistically significant, $\underline{F}(1, 67) = 0.68$, $\underline{p} = .41$ (a > .05). Subjects who received the captioning treatment had no statistically higher post-test mean scores on the TOEFL Listening Comprehension test than students who received the no captioning treatment.

However, Table 3 does show a statistically significant difference between the above average English reading proficiency group and the below average English reading proficiency group on the TOEFL Listening Comprehension subtest, $\underline{F}(1, 67) = 26.72$, $\underline{p} < .01$ (a < .05). The above average reading proficiency group performed better than the below average reading proficiency group.

Summary of the Findings

Statistical analysis of the data from this study led to the following findings:

1. Based on the analysis of covariance, there was a statistically significant difference between the treatment groups on scores on the movie test, such that the captioning group performed better than the no captioning group.
2. The analysis of covariance also showed that there was a statistically significant difference between reading proficiency groups in post-test mean scores on the movie test in favor of the above average reading proficiency group.
3. The analysis of covariance revealed that there was no interaction between treatment and reading proficiency in post-test mean scores on the movie test.
4. The analysis of covariance indicated that there was no statistically significant difference between the treatment groups mean scores on the TOEFL Listening Comprehension test.
5. The analysis of covariance showed that there was a statistically significant difference between reading proficiency groups in

post-test mean scores on the TOEFL Listening Comprehension test, in favor of the above average reading proficiency group.

6. The analysis of covariance revealed that there was no interaction between treatment and reading proficiency in post-test mean scores on the TOEFL Listening Comprehension test.

DISCUSSION

The results of this study indicate that there is no interaction between treatment and reading proficiency for post-test mean scores on the movie test and the TOEFL Listening Comprehension subtest. Further, they show that students who receive captioning as knowledge of results feedback on the interactive videodisc program have statistically higher post-test mean scores than students who receive no captioning on the movie test. This finding is consistent with the findings of Boyd and Vader (1972) and Murphy-Berman and Jorgensen (1980).

Therefore, it seems that captioning is effective on listening comprehension of the specific subject matter presented. This result is inconsistent with the findings of Branvold, Chang, Probst, and Bennion (1986), who investigated the effectiveness of an interactive videodisc workstation in teaching content, vocabulary, and idiomatic expressions using the movie Raiders of the Lost Ark. Significant differences in effectiveness between workstations were found only in the area of idiomatic expressions. The current study does not specifically address idiomatic understanding, though idiomatic expressions are very important for understanding content. However, this study does find an effect on specific content comprehension.

The results also show that students in the above average reading proficiency group have higher posttest mean scores than the below average reading proficiency group on the movie test and on the TOEFL Listening Comprehension test. Therefore, listening comprehension has a close relationship with reading proficiency. This finding is again congruous with the findings of Murphy-Berman and Jorgensen (1980). It is suggested that students trying to improve their English listening comprehension skills should learn more about written English vocabulary and idiomatic expressions, as well as auditory intonation and stress of vocabulary. Additionally, students need to learn more about slang or common expressions that are usually heard in television programs, in the movies, and in daily life.

During the study, informal observation revealed that subjects used background knowledge in listening comprehension. They knew the history and the main characters of the movie The Last Emperor. This observation is consistent with the findings of Johnson (1981), Kitao (1989), Long (1989, 1990), Samuels (1984), and Van Dijk (1980).

This use of background knowledge is not likely to be a confounding variable since subjects were randomly assigned to groups and the content was the same for all subjects. Background knowledge has no effect on the TOEFL Listening Comprehension test, because TOEFL test is developed for evaluating students' general English proficiency.

Schema or cultural background knowledge is an essential component of second language comprehension. However, Kitao (1989) argues that second language classes generally use the grammar-translation method, which does not emphasize the use of background knowledge. This is true in Taiwan. Previous studies indicate that schemata can be taught (Brooks & Dansereau, 1983; Brown, Smiley, Day, Townsend, & Lawton, 1977). Hence, second language educators need to know which instructional designs and strategies for teaching scripts (schema) will be most effective and efficient in specific instructional environments. It is possible that background knowledge helped students understand the content and context of the movie The Last Emperor. The effect of background knowledge remains to be investigated.

In this study, captioning as KR feedback was provided under two conditions in the captioning treatment group. When a subject answered correctly, captioning was provided after a delay of three seconds. When a subject answered question incorrectly twice, captioning was also provided after a delay of three seconds. Hence, the captioning feedback may be regarded as delay of knowledge of results feedback. Swinnen et al. (1990) investigated motor skills learning under three conditions: (1) an instantaneous KR condition in which subjects received KR immediately after response completion, (2) a delayed KR condition in which subjects had a KR-delay interval of eight seconds, and (3) an estimation condition in which subjects were required to estimate their movement time during an eight seconds KR-delay interval. They report that because instantaneous KR provides the learners with information about the success of their response, it reduces the subjects' motivation to evaluate their responses as frequently or intensively as subjects in the delayed or estimation conditions. Thus, "instantaneous KR can discourage the processing of other kinds of information, such as intrinsic response-produced feedback that would lead to the learning of the capability to detect errors in future performances" (p. 715). They conclude that instantaneous KR degrades learning because it reduces the development of error-detection capabilities.

Although the Swinnen et al. (1990) study was not conducted using interactive video, any one of the three KR conditions could be applied to the design of an interactive videodisc program. During the current study, it was informally observed that subjects were actively examining the captioning in order to find out what they misunderstood when they answered incorrectly. This learning process may lead to learning error-detection capabilities and actively involves the student in caption interpretation. Subjects took notes, consulted an English dictionary or idiomatic handbook, or discussed the results with the investigator. These observations provide evidence that knowledge of results feedback has a strong informational property that encourages subjects to use this information for performance enhancement. KR also allows subjects to feel comfortable with their mastery of the material. These findings are consistent with the findings of Swinnen et al. (1990) and Cohen (1985).

During the experiment, subjects were observed operating the interactive videodisc system, and informally interviewed. Subjects indicated that the interactive videodisc program was highly motivational and interesting. This observation is consistent with the finding of Branvold et al. (1986), Koskinen, Wilson, & Jensema (1986), and Kearsley (1990). Some subjects added that the material was easy to understand because of the contextual cues, body language, and facial expressions of the speakers. However, one cannot be certain that the students' high motivation is not due to the use of the new technology of interactive video. Hence, the motivation issue must be investigated. Such investigation requires longer treatments, experienced users of the technology, and a measuring instrument for motivational effect.

An alternative approach to investigate the motivation issue would be the use of Keller's ARCS model (1987) as the basis for analyzing the motivational design of the instructional treatment. ARCS is an acronym that stands for attention, relevance, confidence, and satisfaction. With respect to attention, the movie The Last Emperor has won many Oscar Awards and tells a fascinating story. It gains and maintains student attention. With respect to relevance, Taiwanese students are familiar with the content of The Last Emperor and it relates to their modern Chinese history class. Students may be motivated to compare what they see in the movie with what they study in their textbook. With respect to confidence, in this program, 90% correct on the first try of answering the embedded questions was necessary to move to the next chapter. Learners are aware of evaluative criteria and performance requirements (Keller & Kopp, 1987). In addition to stimulating the need to achieve, it also helps build an expectancy that success will be due to personal effort if the goal is achieved (Keller & Kopp, 1987). With respect to satisfaction, KR allows subjects to feel comfortable with their mastery of the material. In addition, "The knowledge of results promotes learning by confirming correct responses and correcting wrong ones, but it also has a motivational effect in that it allows the achievement-motivated person to get a measure of success" (Keller & Kopp, 1987, p. 315).

The treatment used in this study had no apparent impact on general listening comprehension skills. However, this may be due to the use of only one videodisc program and limited practice. It is difficult to master listening comprehension of a second language with only five hours practice over ten weeks on only one content area. It is possible that an effect on the general listening skills measured by the TOEFL Listening Comprehension test could be achieved if more videodisc programs on a wide variety of topics were used and if much more practice time was provided for the students.

Conclusions and Implications

In consideration of the limitations in this study and the statistical analysis of the data, the following conclusions were drawn:

1. Based on the finding that significant differences existed between the treatment groups on the movie test, it was concluded that captioning used as knowledge of results feedback improves listening comprehension on specific content for Taiwanese college freshmen students.
2. Based on the finding that no significant differences existed between the treatment groups on the TOEFL Listening Comprehension subtest, it was concluded that the captioning used as knowledge of results feedback does not improve general listening comprehension skills. However, this result may be due to limited exposure to the treatment: five hours over ten weeks. It may also be due to the lack of content variety.
3. Based on the finding that significant differences also existed between the above average English reading proficiency group and the below average English reading proficiency group on the movie test and the TOEFL Listening Comprehension subtest, it was concluded that English listening comprehension may be closely related to English reading proficiency.
4. Informal interviews with some subjects during the study indicated that they were not embarrassed or intimidated when they could not understand the content of the videodisc program. They stated that the learning experience was pleasant and free from anxiety. From these comments it may be concluded that the videodisc and microcomputer technologies have demonstrated a friendly environment that can be easily integrated into teaching foreign languages and reduce students' anxiety and embarrassment.

The present results have implications for educational practice. Informal observations suggest that captioning as KR may encourage the learners to examine new vocabulary, idiomatic expressions, and their usage. Captioning as knowledge of results feedback does appear to encourage learners to actively interpret the information, draws learners attention, and facilitates the learning of a second language. However, the findings show that the specific content treatment did not improve general listening comprehension skills. If the goal is to improve general listening comprehension, then treatments of covering many different subject areas may be used. If the goal is to improve comprehension of specific content then captioning provides a tool to assist the learner.

The current findings and students' reactions suggest that an interactive videodisc system has the potential to improve English as a second language learning. This is especially important since qualified English language teachers for listening and speaking skills are in short supply in Taiwan and learners differ widely in entry skills.

Table 1

Pre-test and Post-test for the TOEFL Listening Comprehension and the Movie Test

Reading Proficiency	Treatment		Captioning		No Captioning	
		n	M	SD	M	SD
Above Average	TOEFL Pre-test	36	42.94	4.32	41.67	3.55
	TOEFL Post-test	36	46.56	3.90	45.67	2.99
	Movie Post-test	36	66.72	1.36	60.39	2.30
Below Average	TOEFL Pre-test	36	39.17	2.50	39.94	3.70
	TOEFL Post-test	36	41.44	3.22	41.17	3.84
	Movie Post-test	36	62.83	2.43	55.50	3.82

Table 2

Two-Way Analysis of Covariance for the Movie Test by Treatment and Reading Proficiency

Source	SS'	df	MS'	F	p
Covariates	263.85	1	263.85	46.37	
Treatment (T)	820.58	1	820.58	144.21*	< .01
Reading Proficiency (R)	194.90	1	194.90	34.25*	< .01
T x R	12.28	1	12.28	2.16	.15
Within	381.52	67	5.69		
Total	1662.61	71			

*$.95F_{1,67} = 3.99$, $a < .05$.

Note: "The SS do not normally add up to the model SS." (SAS/STAT user's guide, 1990, p. 936).

Table 3

Two-Way Analysis of Covariance for the TOEFL Listening Comprehension Test by Treatment and Reading Proficiency

Source	SS'	df	MS'	F	p
Covariates	900.85	1	900.85	239.50	
Treatment (T)	2.56	1	2.56	.68	.41
Reading Proficiency (R)	100.49	1	100.49	26.72*	< .01
T x R	5.37	1	5.37	1.43	.24
Within	252.01	67	3.76		
Total	1261.28	71			

*$.95F_{1,67} = 3.99$, $a < .05$.

BIBLIOGRAPHY

Allen, B.. S. (1986). A theoretical framework for interactivating linear video. Journal of Computer-Based Instruction, 13(4), 107-112.

Anderson, John. R. (1990). Cognitive psychology and its implications. (3rd ed.). New York: W. H. Freeman and Company.

Bilingual education. (1990, September 19). Education Week. p. 10.

Boyd, J., & Vader, E. A. (1972). Captioned television for the deaf. American Annals of the Deaf, 117(1), 34-37.

Branvold, D., Chang, L. L., Probst, G., & Bennion, J. (1986). Effectiveness of the interactive videodisc workstation in use in the English language center at Brigham Young University. CALICO Journal, 4(2), 25-39.

Brooks, Larry. W., & Dansereau, Donald. F. (1983). Effects of structural schema training and text organization on expository prose processing. Journal of Educational Psychology, 75(6), 811-820.

Brown, Ann., Smiley, S. S., Day, J. D., Townsend, M. A., & Lawton, S. C. (1977). Intrusion of a thematic idea in children's comprehension and retention of stories. Child Development, 48, 1454-1466.

Byrnes, Heidi. (1984). The role of listening comprehension: A theoretical base. Foreign Language Annals, 17(4), 317-329.

Call, Mary. E. (1985). Auditory short-term memory, listening comprehension, and the input hypothesis. TESOL Quarterly, 19(4), 765-781.

Campbell, D. T. & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research. Boston: Houghton Mifflin Company.

Carroll, J. B. (1986). Second language. In R. F. Dillon & R. J. Sternberg (Eds.), Cognition and instruction. Orlando, FL: Academic Press.

Chastain, Kenneth. (1988). Developing second-language skills: Theory and practice. (3rd ed.). NY: Harcourt Brace Jovanovich, Inc.

Cohen, Vicki. B. (1985). A reexamination of feedback in computer-based instruction: Implications for instructional design. Educational Technology, 25(1), 33-37.

Donaldson-Evans, Mary. (1981). Auditory comprehension in the foreign conversation class. The Modern Language Journal, 65, 166-173.

Farrel, J. M. (1984). The national captioning institute, NCI News, Falls Church, VA: National Captioning Institute, August 18.

Fletcher, J. D. (1989). Report to Congress on the potential of interactive videodisc technology for defense training and education (ERIC Document Reproduction Service No. ED 310 732).

Gagne, Robert. M., Briggs, Leslie. J., & Wager, Walter. W. (1988). Principles of instructional design (3rd. ed.). NY: Holt, Rinehart, and Winston, Inc.

Gronlund, Norman. E. (1988). How to construct Achievement tests. (4th ed.). Englewood Cliffs, NJ: Prentice-Hall, Inc.

Javetz, Esther. (1986). Interactive video: A tool for developing listening comprehension in second-language learners. Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, April 1986. ERIC Document Reproduction Service No. ED 271 029).

Johnson, Patricia. (1981). Effects on reading comprehension of language complexity and cultural background of a text. TESOL Quarterly, 15, 169-181.

Kearsley, Greg. (1990). Computers for educational administrators: Leadership in the information age. Norwood, NJ: Ablex Publishing Corporation.

Keller, John. M. (1987). Development and use of the ARCS model of instructional design. Journal of Instructional Development, 10(3), 2-10.

Keller, John. M., & Kopp, T. W. (1987). An application of the ARCS model of motivational design. In C. M. Reigeluth (Ed.), Instructional theories in action: Lessons illustrating selected theories and models. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kim, W. C. M. (1987). The colloquial Korean interactive videodisc project. CALICO Journal, 4(4), 71-81.

Kitao, S. Kathleen. (1989). Reading, schema theory and second language learning learners. (ERIC Document Reproduction Service No. ED 290 026).

Koskinen, Patricia. S., Wilson, R. M., & Jensema, C. J. (1986). Using closed-captioned television in the teaching of reading to deaf students. American Annals of the Deaf, 131(1), 43-46.

Krashen, Stephen. D., & Terrell, Tracy. D. (1983). The natural approach: Language acquisition in the classroom. Oxford: Pergamon Press.

Krashen, Stephen. D., Terrell, Tracy. D., Ehrman, M. E., & Herzog, M. (1984). A theoretical basis for teaching the receptive skills. Foreign Language Annals, 17(4), 261-275.

Kulik, James. A., & Kulik, Chen-Lin. C. (1988). Timing of feedback and verbal learning. Review of Educational Research, 58(1), 79-97.

Lange, Robert. R., & Grovdahl, Elba. C. (1989). Does anyone really use instructional systems design? Educational Technology, 29(10), 34-37.

Larson, Mark D. (1984). Follow-up to the convention: The voice-based learning system. Hispania, 67, 698-699.

Long, Donna. R. (1989). Second language listening comprehension: A schema-theoretic perspective. Modern Language Journal, 73(1), 32-40.

Long, Donna. R. (1990). What you don't know can't help you: An exploratory study of background knowledge and second language listening comprehension. Studies in Second Language Acquisition, 12(1), 65-80.

Mayer, Richard. E. (1987). Educational psychology: A cognitive approach. Boston: Little, Brown and Company.

Morley, J. (1985). Listening comprehension: Some ideas for developing self-access self-study materials. TESOL Teaching English Abroad Newsletter, 3-5.

Murphy-Berman, Virginia, & Jorgensen, Julie (1980). Evaluation of a multilevel linguistic approach to captioning television for hearing impaired children. American Annals of the Deaf, 125(9), 1072-1081.

Paulston, Christina B., and Bruder, Mary. N. (1976). From substitution to substance: A handbook of structural pattern drills. Rowley, MA: Newbury House Publishers, Inc.

Postovsky, Valerian A. (1974). Effects of delay in oral practice at the beginning of second language learning. Modern Language Journal, 58, 229-239.

Price, K. (1983). Closed-captioned TV: An untapped resource. MATSOL Newsletter, 12(1), Fall.

Rivers, Wilga M. (1971). Linguistic and psychological factors in speech perception and their implications for teaching materials. In The psychology of second language learning, Pimsleur, P., and Quinn, T. (Eds.), 123-134. London: Cambridge University Press.

Rivers, Wilga M. (1981). Teaching foreign language skills (2nd ed.). Chicago: The University of Chicago Press.

Rivers, Wilga M., & Temperley, Mary S. (1978). A practical guide to the teaching of English as a second or foreign language. NY: Oxford University Press.

Russell, James D., & Blake, Bonnie L. (1988). Formative and summative evaluation of instructional products and learners. Educational Technology, 28(9), 22-28.

Salmoni, Alan W., Schmidt, Richard A., & Walter, Charles B. (1984). Knowledge of results and motor learning: A review and critical reappraisal. Psychological Bulletin, 95, 355-386.

Samuels, S. Jay (1984). Factors influencing listening: Inside and outside the head. Theory into Practice, 23, 183-189.

SAS/STAT user's guide. (1990). Version 6. (4th ed.). Cary, NC: SAS Institute Inc.

Schitai, Amit (1989). The design and development of an interactive videodisc for foreign language learning. Educational Technology, 29(7), 48-52.

Schneider, Edward W., & Bennion, Junius L. (1983). Veni, vidi, vici, via videodisc: A simulator for instructional conversations. System, 11(1), 41-46.

Sherwood, Robert D., Kinzer, Charles K., Hasselbring, Ted S., Bransford, John D., Williams, Susan M., & Goin, Laura I. (1987). New Directions for videodisc. The Computing Teacher, 14(6), 10-13.

Swinnen, Stephen P., Schmidt, Richard A., Nicholson, Diane E., & Shapiro, Diane C. (1990). Information feedback for skill acquisition: Instantaneous knowledge of Results degrades learning. Journal of Experimental Psychology: Learning, Memory, and Cognition, 16(4), 706-716.

Swinnen, Stephen P., Vandenberghe, Joost, & Van Assche, Erik (1986). Role of cognitive style constructs field dependence-independence and reflection-impulsivity in skill acquisition. Journal of Sport Psychology, 8, 51-69.

Tighe, Viola F., and Zufelt, David (1988). Computer participation in second language teaching. Educational Technology, 28(12), 51-53.

Truett, Carol, & Gillespie, Lori (1984). Choosing educational software: A buyer's guide. Littleton, CO: Libraries Unlimited, Inc.

Ur, Penny (1984). Teaching listening comprehension. Cambridge, London: Cambridge University Press.

Van Dijk, Teun A. (1980). Macrostructures. Hillsdale, NJ: Lawrence Erlbaum Associates.

West, G. (1989). An interactive video program: TOPIC (Training for Oral Proficiency Interviewing Competence). CALICO Journal, 6(3), 51-59.

Wipf, Joseph A. (1984). Strategies for teaching second language listening comprehension. Foreign Language Annals, 17(4), 345-348.

Wyatt, David H. (1984). ESL applications of the computer-controlled videodisc player. Computers and the Humanities, 18, 243-249.

Title:

Faculty Development and Instructional Technology in Selected Colleges and Universities

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Introduction

Faculty development is an issue at most institutions of higher education (Alfonsi,1990). An increasing knowledge base in most disciplines, a more culturally diverse student body, more stringent retention, tenure and promotion requirements, an increased interest in faculty evaluation, and a demand for alternative modes of instruction have fostered and even demanded interest in faculty development programs (see Diehl and Simpson, 1989; Berman and Skeff, 1989; American Association of University Profoessors, 1990). Alternative modes of instruction have begun inroads on the traditional method of content delivery--the lecture. These modes of instruction often emphasize instructional technology--both in design and planning and in delivery (University of Maryland, 1984).

Faculty, too often, are poorly trained in educational methods and the newer technologies of instruction. Instructional technologists by their nature and training are often proactive and tend to take a lead in programs aimed at change--especially in the areas of instruction. Many workshop and seminar offerings in faculty development (FD) programs are presented by instructional technologists and include content related to instructional technology (Marbler and Lawyer, 1984; Albright, 1989).

Purpose of Study

The purpose of this study is to investigate the role of instructional technology (IT) related to planning, delivery, evaluation and content selection. We want to investigate what internal organizations of the university sponsor and deliver FD offerings and where the ultimate responsibility of the FD program lies. We wish to determine the types of offerings related to IT and their relative frequency and attendance. Answers to questions related to planning, evaluation, and effect on instruction and faculty growth and involvement are sought.

Methodology of Study

Two types of questionnaires were designed and used in this study. Three types of respondents were surveyed. The sample was the 170 USA colleges and universities included in **Masters Curricula in Educational Communications and Technology: A Descriptive Directory** by Johnson, et al, 1989. Each of these institutions was identified as having either MA or Ph.D. programs in educational communications and technology. Since the major emphasis of this Faculty Development study was related to instructional technology it seemed logical that having an academic program in educational communications and technology would have some effect on the planning, development, and evaluation of such programs and on the curricular content of the FD program.

The subjects participating in this study were media services directors, department heads of instructional technology academic programs and the person in the institution responsible for the faculty development program (FD officer). Three color-coded questionnaires were sent to the chief academic officer who was requested to see that the appropriate persons received them. The questionnaires directed to the media services directors and IT academic head were the same and requested the perceptions of these subjects concerning eleven statements relevant to the FD program at their institution. The questionnaire directed to the institution's FD officer included these same items, but additional data was requested related to campus organizations and departments which offered FD workshops/seminars and administrative responsibility, types of workshops/seminars offered with instructional technology content and programmatic planning.

The eleven statements to which the respondents reacted related to planning, evaluation, input, support, impact, promotional activities, resources and the role of instructional technologists in faculty development. A semantic differential was used which included Strongly Agree, Agree, Agree Slightly, Disagree Slightly, Disagree, and Strongly Disagree. The responses of these three types of subjects were statistically compared by computing the Average Weighed Value and then using a Rank Difference Correlation (Spearman rho).

A Previous Study

Some data from a similar study (Stephens, 1991), reported at the 1991 Association for Educational Communications and Technology conference in Orlando, are incorporated into this study. The present study was done as a follow-up using the same institutions surveyed in 1990. In the first study, a survey instrument was sent to the person listed as being the chair of the program offering masters or doctoral degrees in educational communications and technology. One hundred and twenty-four institutions responded. In the latter study, the number of institutions responding is an unknown, because three different types of respondents were surveyed--the FD officer, the director of educational media services, and the academic head of the IT program. At least 65 institutions responded, but the actual number is probably more as no institution identifying code was used. A color code, however, was used to delineate the type of respondent. Sixty-five FD officers, 56 directors of media service centers (IRC), and 47 heads of IT academic programs responded.

Findings

Administrative Responsibility

In the 1990 study, with 124 institutions responding, the majority of offices contributing to faculty development were the Faculty Development Office (30), the IRC (28) and the Office of Academic Affairs (31). In most cases, Academic Affairs was ultimately responsible for FD programs. In the 1991 study, with data being provided by the designated FD officer, the data reflected a similar pattern (see **Table 1**) with responsibility residing in the FD Office and the Academic Affairs Office.

UNIVERSITY ORGANIZATIONS OFFERING FD WORKSHOPS				
		FREQUENCY		RESPONSIBILITY
ORGANIZATION				
FD Office		25		13
IT Academic		17		
Other Academic		11		
Sci.		18		
Computer Sci.		7		
Info. Tech.		24		
School of Educ.		13		
HRD		18		
Acad. Affairs		42		24

Table 1. Administrative Responsibility for Faculty Development Programs.

779 745

Faculty Development Offerings and Attendance

The 1990 study provided more data related to numbers of workshops/seminars and attendance than the 1991 study. But the trends are similar. The earlier study compared instructional design-related offerings, media design/use offerings, and any workshop/seminar related to computer technology. The latter study had five categories--instructional design, media design/use, computers, interactive technologies, and alternative modes of instruction. **Table 2** provides data on attendance which is also graphically displayed in **Figure 1**. By eliminating Alternative Modes and combining Computers and Interactive Technologies for 1991, converting attendance values to percentages and then comparing 1990 with 1991 we can see in **Figure 2** that Media Design/Use is declining, Instructional Design is increasing and that Computer Technologies are in the majority of FD offerings related to instructional technology.

ATTENDANCE AT FD WORKSHOPS/SEMINARS					
	INSTRUCTIONAL DESIGN	MEDIA PROD./SEL.	COMPUTER USES	HYPERMEDIA/ INTERACTIVE	ALTERNATIVE MODES
ATTENDANCE	783	337	952	420	530
%AGE OF TOTAL	36	16	44	19	25

Table 2. Attendance at FD Workshops and Seminars.

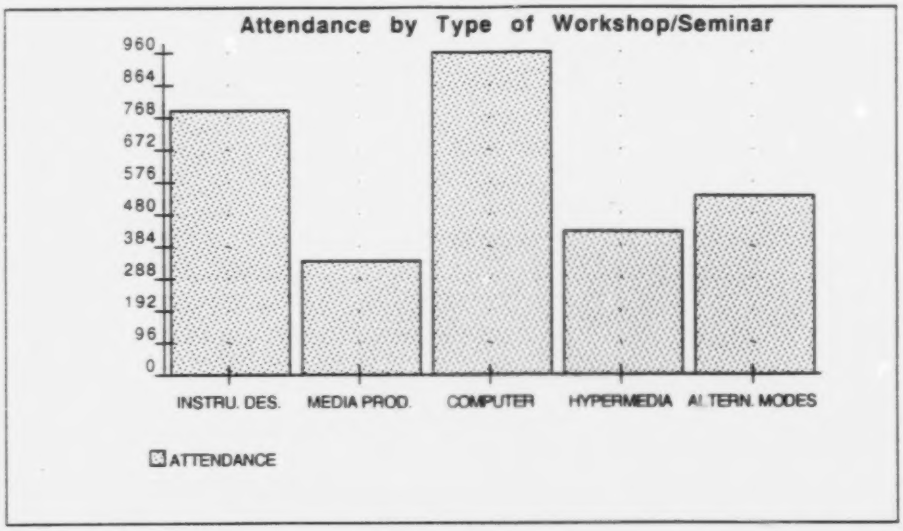

Figure 1. Graphic Comparison of Attendance at FD Workshops

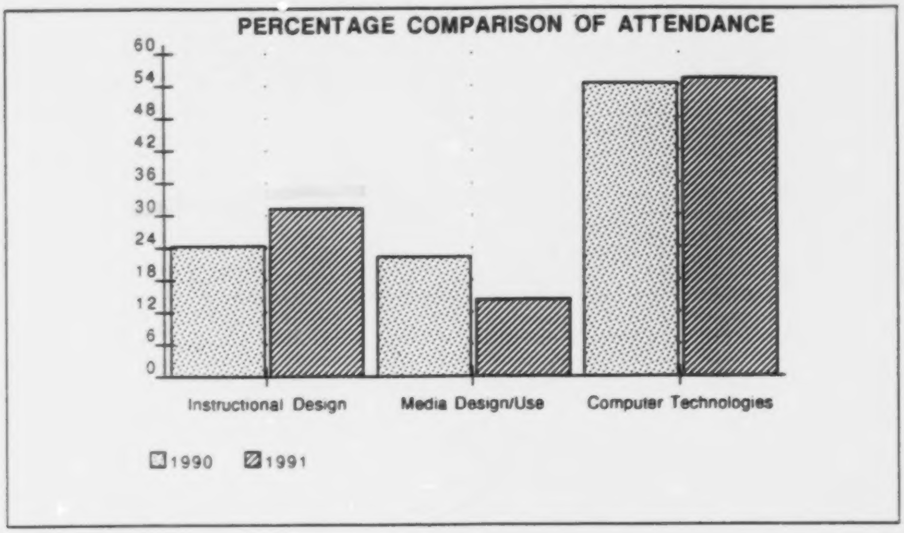

Figure 2. Percentage Comparison of Attendance

Programmatic Planning and Evaluation

A caveat of instructional technology and design is that planning and evaluation are a part of any program development activity. The data provided by faculty development officers from 65 institutions was disappointing in that regard. However, faculty input into program development was an encouraging factor. Only 34 % of the institutions responding indicated that formal needs assessment procedures were used in programmatic planning. Even more distressing was that only 26 % had a formalized program evaluation system. And 43 % reported that a formal University policy existed concerning faculty development. On the other hand all respondents as a group indicated that Academic Administration policy strongly supports faculty development. The data regarding programmatic planning is summarized in **Table 3**.

FD PROGRAMMATIC PLANNING				
	Yes	%	No	%
Is there a FD program planning committee?	35	54.00%	30	46.00%
Is formal needs assessment a part of planning?	22	34.00%	43	66.00%
Does the faculty participate in planning?	42	65.00%	23	35.00%
Is there a formalized program evaluation system?	17	26.00%	49	74.00%
Is there a formalized University policy concerning FD?	28	43.00%	37	57.00%

Table 3. Faculty Development Programmatic Planning.

Perceptions of Respondents

Each type of respondent was asked to react to the same eleven statements related to the FD program at his/her institution. Their responses were remarkably similar. After calculating the Average Weighted Mean for each group of respondents on each item a Rank-Difference Correlation (Spearman rho) was computed comparing IT department heads perceptions with media services directors and with FD officers. Then media service directors were compared with FD officers. In each case there was an extremely high positive correlation among their cumulative responses. This data is summarized in **Table 4.**

RANK-DIFFERENCE CORRELATION AMONG RESPONDENTS' PERCEPTIONS	
1. IT Academic Head Correlation with FD Officer	r = .8636
Extremely positive correlation.	
2. IT Academic Head Correlation with IRC Director	r = .829
Extremely positive correlation.	
3. FD Officer Correlation with IRC Director	r = .784
Very Positive Correlation	

Table 4. Summary of a Rank-difference Correlation Among Respondents' Perceptions.

The Average Weighted Value for the responses of each group of subjects is presented in Tables 5 through 7. **Table 5** refers to Faculty Development Officers' perceptions about the FD program. These subjects have the perception that there is a shortage of supporting resources, that needs assessment does not play a significant part in planning, that there is no effective evaluation plan, that participation in FD does not strongly affect promotion and tenure, and that instructional technologists play only a minor role in the Faculty Development Program. There is remarkable agreement on these points among all three types of respondents.

FD Officers most strongly supported the concept that Academic Administration policy supports the FD program. They also believed that the program had a positive impact on quality of instruction and that faculty were solicited for input. IRC Directors and IT Department Heads disagreed with FD Officers in more strongly agreeing with the concept that needs assessment is an important tool in planning the FD program. However, IRC Directors, as a group, did not feel in agreement with IT Department Heads and FD Officers that the FD program was having a positive impact on instruction.

Conclusions, Implications, and Recommendations

Conclusions that may be made based on the findings of this study are:

1. Many departments and committees on campus provide workshops/seminars that are designed to assist faculty in learning or improving professional skills.

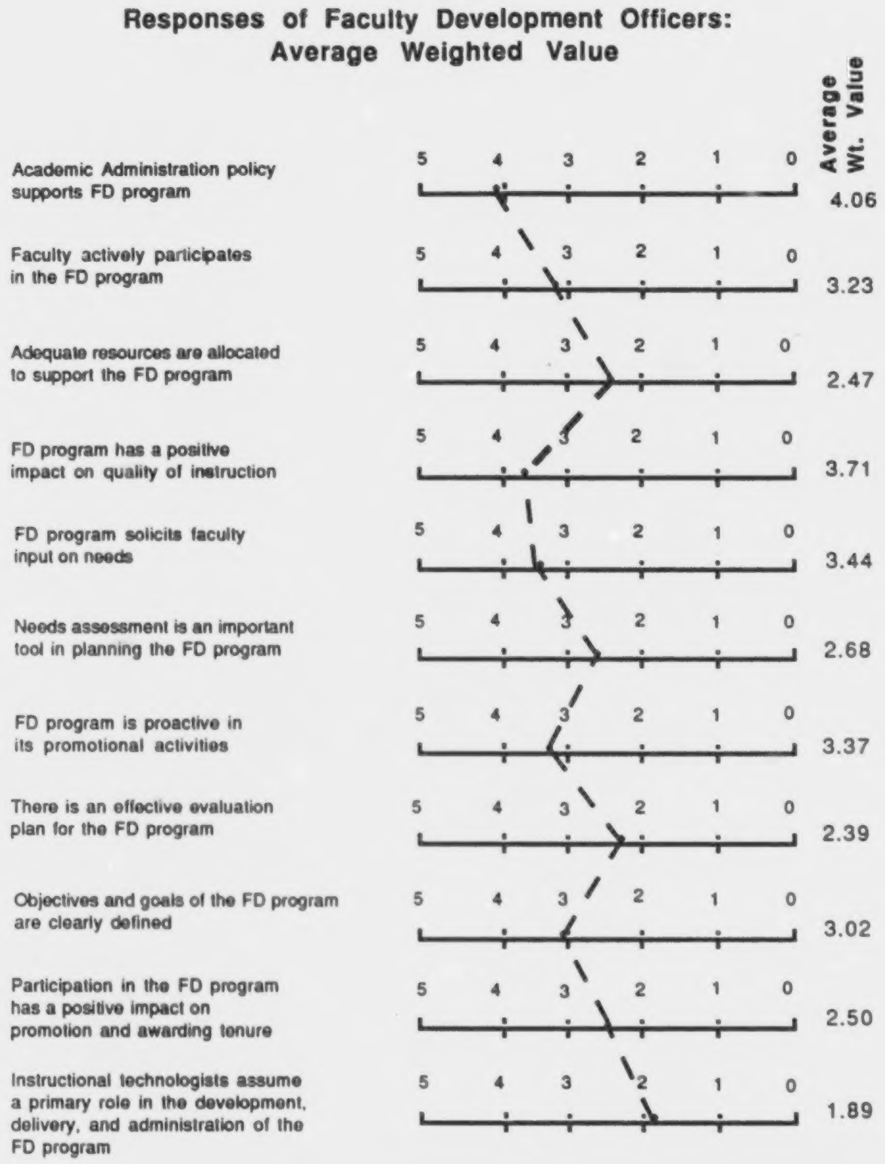

Table 5. Average Weighted Value of Faculty Development Officers' Perceptions.

2. Most often, the faculty development program is either administered through the FD Office or through the Academic Affairs office. Ultimately, all such activities are accountable to the Academic Affairs office.

3. The majority of workshop/seminars offered which relate to instructional technology are involved with computer technology.

4. Workshops related to media design and use are on the decline.

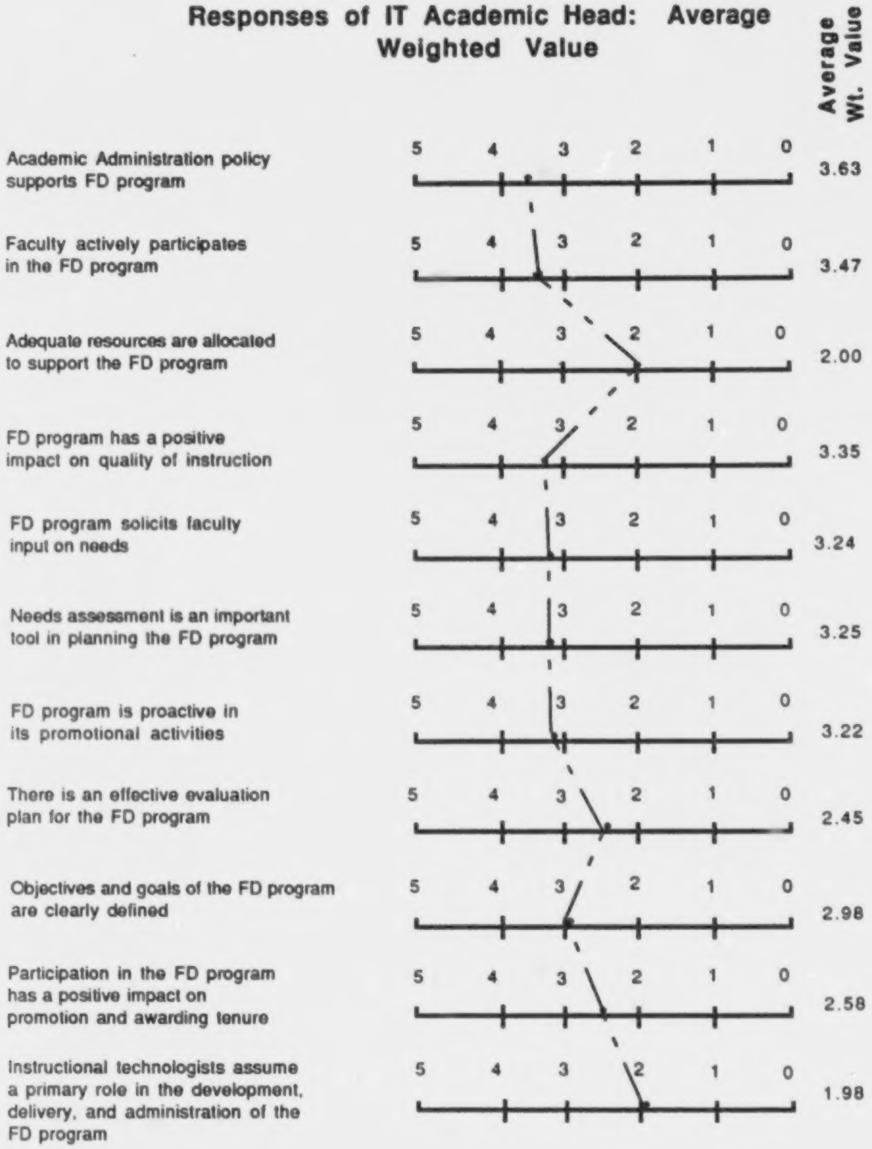

Table 6. Average Weighted Value of IT Department Heads' Perceptions

5. Instructional design principles such as needs assessment and evaluation in programmatic planning of faculty development programs are underutilized.

6. There is remarkable agreement among the three groups of subjects with a strong positive correlation on the perceptions about the eleven statements used to describe the faculty development program.

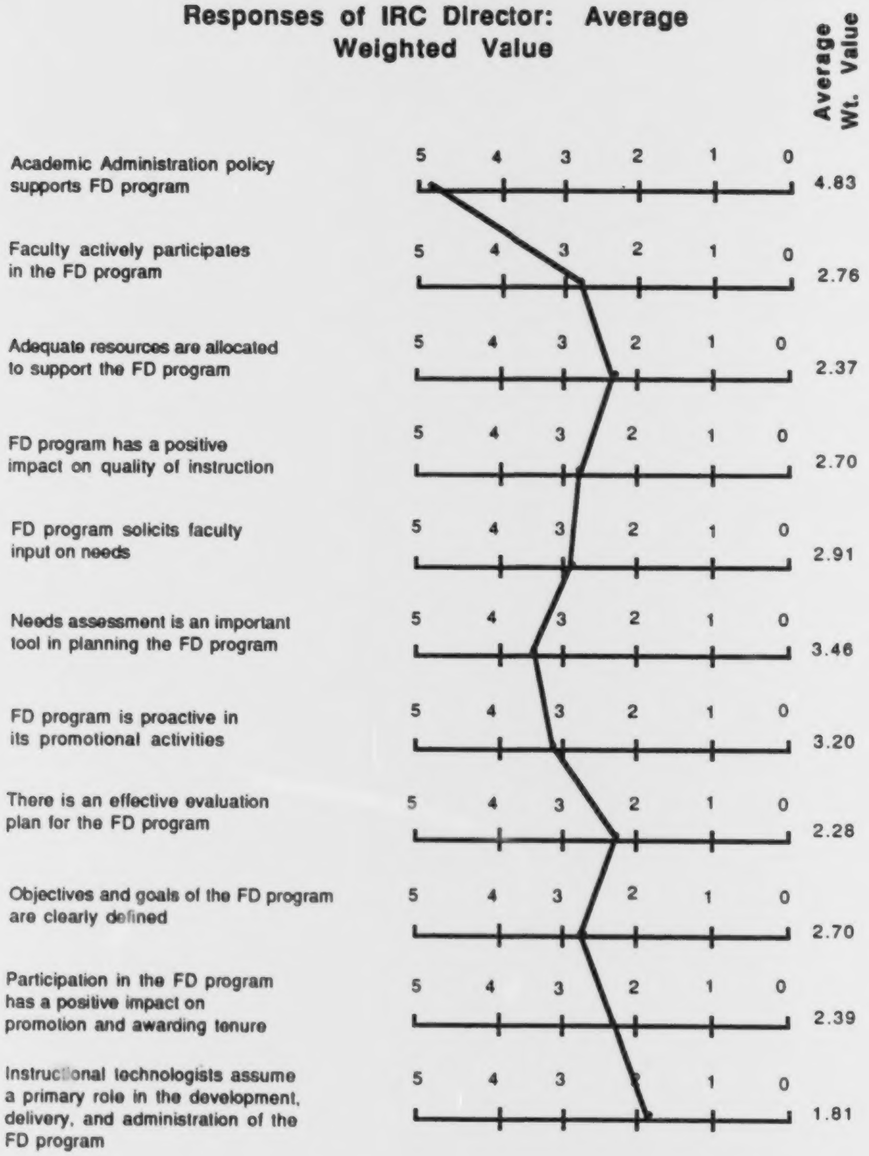

Table 7. Average Weighted Value of IRC Directors' Perceptions.

It may be implied that instructional technologists and instructional design principles are being under utilized in the development, administration, and delivery of faculty development program offerings. The implications of this indicate a need for a more proactive stance from instructional technologists in participation in the FD program. In addition, these professionals need to develop greater visibility on campus in their modeling of good teaching and helping others increase their productivity through technology.

It is recommended that a more comprehensive study be made related to faculty development with on-site visits cooperatively working with appropriate campus personnel and carefully monitoring the FD program regarding planning activities, needs assessment, evaluation and kinds and numbers of workshops with attendance figures. Standards should be developed by which Faculty Development programs can be evaluated and model programs recognized. What makes an effective program? What can be done to ensure that the program remains effective?

References

Albright, Michael (1989). The instructional improvement functiion: An approaching imperative in higher education. *Media Management Journal*, 5 (2), 21-28.

Alfonsi, A. (1985). Teaching professors to teach. *New York Times: (Education Summer Survey)*, August 18, 1985, 33.

American Association of University Professors (1990). *Collective bargaining agreement between Western Michigan University professors:* Washington, D.C.: AAUP.

Berman, J. & Skaff, K. (1989). Developing the motivation for improving university teaching. *Innovative Higher Education*, 12 (2), 114-25.

Diehl, P. & Simpson, R. (1989). Investing in junior faculty: The teaching improvement program. *Innovative Higher Education*, 13 (2), 147-57.

Johnson, J. et al (1989). *Masters curricula in educational communications and technology: A descriptive directory.* Washington, D. C.: Association for Educational Communications and Technology.

Marbler, J. & Lawyer, D. (1984). Microcomputers and teacher training: A systematic university faculty development program. *Teacher Education and Special Education*, 7 (3), 142-48.

University of Maryland (1984). *Improving University teaching. Volume I: Abstracts of contributed papers, seminars, workshops,index of presenters. international conference (10th).* College Park, MD: University of Maryland.

Title:

Training in Japan:
The Use of Instructional Systems Design

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Training in Japan:
The Use of Instructional Systems Design[1]

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Introduction

Instructional systems design (ISD) or the systems approach is being used in the training in the U.S. to an increasing degree, and it is generally successful. However, it is not well-known as to whether this approach is applied in the other countries. One major issue in ISD is its applicability to different contexts, particularly to different countries. Each country has its own approaches and ideas regarding training. There may be situations where ISD is effective, and ones where it does not quite fit, at least not without modification of the ways in which it is generally represented in the literature of the U.S.A. and Europe. Before discussing the effectiveness of ISD and implementing it, an essential step is to understand the context where the training is taking place.

In Japan, the terms "ISD" and "the systems approach" are not found in the field of training. However, this does not mean that the concepts and processes or ISD are not being used. It is possible that certain elements of ISD are being implemented without being identified as such. It will be useful to have a detailed description of what approach is being used in training as well as an overall picture of the training in Japan. This research will help us to understand the current use of ISD, or elements of it, and the possibility of its future use.

Research Questions

The purpose of this research is to obtain a picture of approaches to training in Japan, focusing on its use of ISD. This will serve to assist in answering two questions: "What kind of training is conducted in Japanese companies?" and "To what degree is ISD implemented?" This will provide both practitioners and researchers with valuable information regarding current practices and future potential for ISD.

Method of the Research

The survey method was selected as the most appropriate for the purpose of the research, because it enables the researchers to cover a larger sample than any other method. As for sampling strategy, stratified random sampling was employed to ensure obtaining a sufficient sample within different industries. Six major industries were chosen because their counterparts in the U.S. tend to have strong internal training departments: banks, auto manufacturing, electric machinery, wholesale stores, insurance and securities, and transportation. The researchers selected 121 companies from about 300 companies in the six industries which were listed in the First Section of the stock exchange in Japan in 1990. Before administering to 121 companies, the questionnaire was pilot tested in two Japanese companies and revised. The study was conducted in July and August, 1991.

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[1] This paper, which was used as a handout, is a synopsis of the full-length paper.

Results of the Research

Forty-five companies out of 121 responded (6 out of 20 in banks, 7 out of 20 in auto manufacturing, 11 out of 21 in electric machinery, 8 out of 20 in wholesale stores, 6 out of 20 in insurance and securities, and 7 out of 20 in transportation). Hence, the response rate was 37.5%

The first question was, "Considering all of your employees, when does your company use education and training done off the job (off-JT) more frequently than education and training done on the job (OJT)?" Off-JT refers to training that is offered internally by the company at a training location and requires the employee to leave the work site while attending training. Table 1 indicates the relative use of off-JT and OJT. Through the industries, off-JT is more often used than OJT for orientation of new employees. Half of the companies (22 out of 44) use off-JT more often than OJT as a means of employees' self-development. As for training directly related to the present job, the tendency to use OJT is strong.

Table 1---Companies using off-JT more frequently than OJT for each training objective

Training objective	# of companies (n=44)	Percent
Orientation of new employees	28	64%
Providing employees with an opportunity for self-development	22	50%
Helping employees qualify for future jobs within the organization	19	43%
Helping employees perform their present job well	16	36%
Informing employees of technical and procedural changes	8	18%

The next question was, "Which method or material does your company use most frequently each for technical skills and interpersonal skills? Place a 1 after the most frequently used approach, then indicate the 2nd and 3rd most frequent approach." As a whole, the most frequently used training methods for technical skills are practical training, lecture, and group discussion in that order (Table 2). This is true across the industries, except for wholesales where group discussion and role play / case study are the two more frequently used. A different tendency is found in training methods for interpersonal skills where role play / case study, group discussion, and practical training are the most frequently employed. This is true in each industry, except for transportation where lecture occupies the third place.

Table 2 — Frequency in the use of training methods
(3 points for most frequent, 2 for the next, 1 for the next)

Training Method	Technical		Inter-personal		Total
Group discussion	32	(3)	68	(2)	100
Practical training	55	(1)	42	(3)	97
Lecture	53	(2)	38	(4)	91
Role play / case study	17	(5)	70	(1)	87
A-V media	23	(4)	7	(5)	30
Simulations	6	(6)	6	(6)	12
Correspondance	2	(8)	1	(8)	5
Games	2	(9)	3	(7)	5
Computers	4	(7)	0	(9)	4

Table 3 summarizes the responses to the question, "How does your company obtain training programs?" Developing programs within the company is the most frequent and obtaining training from outside sources is the next frequent way. This tendency is found all through the industries. Forty-one companies out of 44 indicates developing in own company as the most frequent way.

The following questions were asked to companies developing at least some of their own programs. The first question was, "Who develops and delivers your training programs?" Table 4 illustrates that training department plays a central role in both developing and delivering training. Most of the companies indicated that the training department works with either an SME or supervisors. All the companies in banks and transportation stated that the same sections are in charge of development and delivery of training. However, some of the companies in other industries include different sections for development and delivery (such as SMEs and training department for development and SMEs and supervisors for delivery). The use of SMEs external to the company and that of SMEs internal to the company are about the same in the frequency.

Table 3 --- Where to develop training programs
(3 points for the most frequent, 2 for the next, 1 for the next)

Where to develop	Points (# of companies = 44)
In own company	127
In affiliate company	28
From outside	80

Three examples of the ISD model were provided with a question, "Does your company have a similar model or use a similar procedure without a written model?" Only two companies indicated that they have a model similar to the ISD model (Table 5). About 70% of the companies identified that they use a similar procedure, but do not have a specific model to follow. This tendency is found across the industries. Among those who are using a different procedure, half of them recognized such a model would be useful in finding out real needs and responding to them in a timely manner or useful as a check list. Those who find that the model does not look helpful pointed out a lack of flexibility.

Table 4 --- Who are in charge of developing and delivering training programs

	Develop		Deliver	
Who in charge	# of companies n=45	Percent	# of companies n=45	Percent
SME (external)	24	53%	27	60%
SME (internal)	25	55%	31	69%
Supervisors	10	22%	15	33%
Training department	40	89%	35	78%
Others	0	0%	1	0%

While some companies use the ISD procedure for all of their training programs, others use the procedure selectively (Table 6). Differences were found among the industries as to which training categories employ the procedure and which do not. For example, in entry level training, less than half of electric companies and the half of transportation companies use the ISD procedure, while all the banks and wholesales companies use it. For research and engineering, all the companies who conduct such a training use the procedure. The use of the procedure is the lowest in training for entry level workers across the industries, although such a training is identified as the most frequent.use of off-JT.

Table 5 --- Companies using an ISD model or a similar procedure

Use of ISD procedure	# of companies (n=42)	Percent
Own a model	2	5%
Use a similar procedure	29	69%
Use a different procedure	10	24%

For companies using a different procedure, does this kind of model look helpful?

Helpful	4	40%
Not helpful	4	40%
No answer	2	20%

Short answer questions were asked to obtain a closer look at the training situation. The first question was, "How do you decide needs for developing a new program or revising a present program?" Techniques universally identified were questionnaires for previous trainees, interviews with people in relevant levels and sections, and meeting with supervisors or other important people. Among others are breaking down needs from a business plan and collecting information from outside. As for the next question, "How do you determine what the content of a course will be?," almost all the responses indicated that, after finding out needs, the training department holds a meeting either by itself or joined by a section of target audience. As for the question, "Is there a formal process or tool for the design and development of a training material?," no companies stated that they have such a procedure or tool for training materials. It seems that they develop or revise materials case by case, following the previous example. A few companies indicated that they consult with outside information source such as journals and consultants.

The next question was "How and who conducts training evaluation?" The most popular way of evaluation is a combination of questionnaire for trainees on the training program and interview with their supervisors on their job performance after the training. Some companies ask supervisors to write a report on subordinates who went through a training program.

Various efforts were reported on "What kind of approach do you use for improving the effectiveness of training programs?" Follow-ups (evaluation and/or training), a variety of training methods as well as curriculum, and an extensive needs assessment are the three most identified approaches.

Discussion

Much of corporate training and education is made up of OJT, off-JT, and self-development, each of which has its own role. Japanese companies put more emphasis on OJT traditionally; however, this research shows that OJT has established a certain position in large companies. It is used primarily for entry level training and for opportunities for self development.

Table 6 — Use of ISD procedure for each training categories

	Percent (# using ISD procedure /# conducting a particular training)	
Entry level	67%	(20/30)
Production	94%	(15/16)
Clerical work	74%	(14/19)
Sales work	87%	(20/23)
Management skills	90%	(29/31)
Research and engeneering	100%	(12/12)

At this stage, it is not clear how effective formally developed training programs are compared to traditional OJT. Since most of the companies in this study stated that developing training programs on their own with the training department as its center is a primary approach for development, how to develop programs is crucial.

The majority of the companies studied identified that they are using a procedure similar to the ISD model. However, a closer look reveals that what they are doing can be called a general systems approach to problem solving, rather than ISD. The companies follow general steps of systems approach to problem solving, but not detailed steps of ISD, when developing training programs.

The fact that systems approach has already been implemented and also general positive reaction toward ISD models suggest that ISD can be introduced successfully, as a specific application of the systems approach to instruction.

Here, special attention should be paid to the possible perception of ISD as inflexible, which possibly comes from the way ISD is generally described (flowchart, step-by-step task list, and the like). It is recommended that ISD be introduced as a general concept of developing instruction, not as a specific procedure to be followed.

Finally, in closing, it is important to note some differences between the United States and Japan in terms of organizational structures that influence the adoption and utilization of ISD in Japan. In Japan, corporations tend to exercise a high degree of proprietary control over training along with their other internal management and manufacturing processes. Consequently, they seldom bring in outside consultants or vendors to develop training although they may bring in outsiders to present off-the-shelf training. Furthermore, there tend not to be working relationships between professors in the universities and business and industry.

These factors limit the likelihood of full scale adoptions of ISD processes and supporting technologies in the near future, but there do appear to be changes occurring. Professors in some of the leading educational technology programs are conducting innovative research on technology applications in instruction, and are devoting more attention to teaching ISD in their graduate programs. Furthermore, some of them are knowledgeable of the utilization of ISD and technology in education in corporations in the United States. These trends, together with other changes that are occurring in the younger generations of Japanese with regard to their attitudes toward careers, indicate that Japanese will be looking more carefully at training development options that are more efficient than the traditional OJT approaches.

Title:

Choosing a Display Format for Instructional Multimedia: Two Screens vs. One

Author:

C. David Taylor

Choosing a Display Format for InstructionalMultimedia
Two Screens vs. One

The technology for capturing, storing and displaying multiple media with the computer has made revolutionary strides within the past few years. Given the wealth of choices now available to the designer of multimedia courseware—which must be balanced against the technological constraints of a given computer system—the decision about presenting media in an instructional situation is more problematic than ever. Of the many available alternatives for displaying information to the learner, what does the designer need to know in order to make a decision that will further the project goals? This presentation will first give a brief review of multimedia display technology. The second section will describe the technical, theoretical and practical factors that should be considered in making a decision about a display system. Technical decisions involve consideration of the *trade-offs* among the resources of a particular computing system. Theoretical factors draw on research and guidelines from a wide variety of fields that include learning theory and instructional design, human-computer interface design (human factors research), visual learning and media selection. The third section will present a brief description of the decision-making process that went into the design of a multimedia workstation for a plant biology laboratory.

Factors in Decision-making

How do we make decisions about when to use the various media within a single courseware program? A traditional area of instructional design and development concerns *media selection*, and a number of useful models have been developed to aid in choosing the appropriate media to deliver an instructional message (Reiser & Gagne, 1982). The issues raised and discussed in the rationale for these models are highly relevant in the choices of the individual media used within a multimedia system. However, almost all of the relevant research—and the resulting established and tested models—concerns single media used in isolation, and the models were developed well before the advent of multimedia. The question for multimedia, on the other hand, is of a different nature: in the face of the incredibly rich variety of choices, how does a developer or designer choose and *mix* different media to achieve the best effect? This is a different sort of question, and it is the central issue in this article. There are three perspectives on this problem: one based on theoretical principles of learning and instructional design, the second dealing with technical trade-offs within a computer system, and the third purely practical.

Theoretical Factors

Due to its recent emergence, there are no well-demarcated boundaries to multimedia as a field of research. Some authors (cf. DeBloois, 1989) have wisely recommended that we should refrain from spelling out strict guidelines for usage, because it may hinder experimentation in the field. However, several areas of past research are relevant in making decisions about the display of multimedia, although it may require effort and imagination in order to transfer results to this new field. These areas include learning theory and instructional design, media selection, visual learning, and human-computer interface design (from human factors).

Instructional design and learning theory are closely interwoven (cf. Gagne, 1985; Gagne & Briggs, 1979)), and have had a seminal influence on the development of computer-assisted instruction and interactive video (Jonassen, 1988; Hannafin & Rieber, 1989; Hannafin & Phillips, 1987), from which the current conception of multimedia is derived and closely allied. Although multimedia and CAI can make a useful contribution during each part of the instructional process, the method of display is more consequential in some than others. The framework provided by ROPES+ (Hannafin & Rieber, 1989; Hooper & Hannafin, 1988), a technology-oriented "meta-model" for instructional design based on applied cognitivism and information processing theory, is especially useful for application of design principles in the decisions involving display technology. The following discussion of attention, encoding and retrieval and presentation will identify key areas of the instructional-learning process in which the mode of display has the most salient areas of influence.

Attention as a Learner Resource

Attention is a key construct in learning and instruction (Klatzky, 1980; Gagne, 1985) and, for that matter, in any form of communication. Workers in the communications industry, especially in the advertising sector of broadcast media, wage a constant battle to capture the public's attention and direct it favorably toward their product and message. Cognitive learning theorists have demonstrated that attention is a resource with limited capacity that can be allocated to only a few processes at one time (Kahneman, 1973; Norman, 1976; Klatzky, 1980). In addition, more attention is required for unfamiliar material, such as normally occurs in an instructional situation. As such, the designers of multimedia must be constantly aware that they are also working to gain, hold, control and direct—and even provide relief for—the learner's attention. This power should not be taken lightly, and, indeed, it implies a serious responsibility for the cognitive status of the learner.

In the events of instruction model (Gagne, 1985), *gaining attention* serves as the "wake-up" call for learning: it prepares the stage for learning and can be coordinated with orienting devices, such as advance organizers (Ausubel, 1963) and stimulating the recall of previously-learned information. Multimedia, because of its novelty, is currently a premier device for attention-getting. However, attention-getting should be used cautiously (getting does not guarantee holding attention). For example, it would not be prudent to waste a large part of the system resources on a flashy opening sequence, and then use a text-only presentation during the remainder of the instructional program. It is easy to irritate users and lose their attention if high expectations are not fulfilled; the designer should be careful to deliver on all promises, or the result could easily be a net negative effect.

Creative uses of multimedia can facilitate the gaining, directing and holding of learner attention. For example, orienting activities (such as advance organizers or presentation of objectives prior to instruction) are "mediators through which new information is presented" (Hannafin & Phillips, 1987) and prepare the learner for forthcoming instruction. Advance organizers (Ausubel, 1963) have mixed claims of success, it is often asserted, because they are not applied according to prescription (Ausubel, 1977; Mayer, 1979), which is at a "higher level of abstraction, generality and inclusiveness" than the subsequent content (Ausubel, 1963). It has been recognized that video is not an ideal medium for presenting detailed material, but is better used for broader, abstract material, possibly with an emotional appeal. Therefore, a short, abstract video segment may serve well as the medium for an advance organizer, and, similarly, for a lesson summarizer. On the other hand, AIME research (Salomon, 1984; Cennamo, Savenye, & Smith, 1991) has shown that television, because it is usually perceived as easy to understand and places few demands on viewers, can cue learners to invest less mental effort in learning program content. Consequently, multimedia designers would be well advised to avoid the look and feel of "television" in the design of their programs; for one thing, this would seem to imply that they should avoid long, linear video sequences and should increase interactivity whenever possible.

The use of multiple media can be useful in providing the variety within a presentation that is important for maintaining and holding attention. Use of the different media can strengthen the power of CAI to vary viewpoints, the pace of a presentation and provide numerous opportunities for interaction and practice. It has also long been recognized that each medium has its own attributes and symbol system that directly or indirectly impacts learners, which renders it more or less suitable for different instructional outcomes and content (Salomon, 1979; Salomon & Gardner, 1986). In addition, different media assume and develop different skills (McCluhan, 1965) at the same time that their messages converge as to the knowledge that they convey (Bruner & Olson, 1973). For this reason, *media selection* has evolved into a well-established decision-making process, and a number of selection models exist that have a variety of formats and take different learner, task, and instructional variables into account. However, almost without exception, these models were developed with the assumption that individual media were to be used in isolation. The advent of multimedia changes the basic ground rules of media selection and usage, and the changes currently underway point toward re-opening this important field of research (Locatis, Charuhas & Banvard, 1990). Kozma (1991) notes that choices about media selection were formerly macrolevel decisions, but with multimedia such decisions can be made more frequently and selectively at the microlevel, which opens up the possibility of selecting media based on individual learner needs and preferences.

A basic premise of this article is that the multimedia devices that are the most powerful in terms of gaining attention also tend to be the most expensive in terms of system resources. Digital motion video and 24-bit color animation, it has already been noted, require extremely large file sizes and extensive CPU loading. These formats cannot be used too freely on most systems available today. The list of presentation formats below represent an assertion by the author—based on intuition, experience and available research—of a range of presentation devices scaled from least attention-holding (1) to most attention-holding (6). It is a relative scale, in that if a screen contained two items with different formats that competed for attention, the item that was higher on the scale would tend to hold the viewer/user's attention more effectively. This list represents testable hypotheses; results could be used in a quantitative trade-off analysis (Norman, 1987).

Attention-getting/holding devices from least to most attention-holding
1. text only
2. Static visual/graphic (varying by color and size)
3. Animated visual/graphic (silent)
4. Sound alone
5. Sound + Movement

An additional assertion is the following list, which represents items that tend to create an unpleasant discord in the user's multimedia experience, and therefore have a net negative effect in attention and, therefore, learning. These are presented in no particular order.

0. Sound vs. movement
0. Incomprehensible, badly-designed static or moving visual
0. Obnoxious sounds
0. Repetitive image, sound, etc.
0. Very slow movement (or response to input) that forces the user to wait before progressing

Research in the relative importance of television production factors is useful for the video and audio aspects of multimedia (Wright & Huston, 1983). For example, it has been found that most learning occurs when audio and video are redundant, that is, are synchronized and repeat and reinforce the same content; when audio and video interfere with each other, learners consistently shift their attention to the video at the expense of the audio track (Hanson, 1989).

Encoding and retrieval are crucial events in instruction; they might even be described as the defining operations of the learning process. Information must be encoded in long-term memory in such a way that it can be retrieved when needed; otherwise, the information is inaccessible and therefore useless, a situation that has been described as *inert knowledge* (Whitehead, 1929). For example, Paivio's (1979) dual-coding hypothesis suggests that encoding can take place in two channels, one visual and the other verbal. Research in this area shows that the more concretely information is presented, the easier it is to picture and remember; the more abstract, the harder it is to picture and remember. One of the strengths of multimedia, obviously, is its wealth of techniques for presenting information in concrete form.

A key principle asserted by the ROPES+ model is that *distinctiveness* at encoding (which should to be distinguished from image clarity) will be related to importance, which will facilitate the retrieval of knowledge. An important conclusion to be drawn from this principle is that designers should save their most distinctive presentation power for key concepts and ideas. A related principle is *spread of activation*, in which superordinate concepts set the stage for learning related, subordinate concepts. This is the same pattern as is used with orienting activities: after attention is directed to the key concept, subsequent subordinate concepts will be associated with the superordinate. A conclusion to be drawn here is that expensive system resources (e.g., high-attention devices, such as animation drawn in 24-bit color, or full motion video) should be reserved for cuing learners as to the importance of superordinate concepts; simpler displays will then suffice in the presentation of related but subordinate concepts. In addition, the association of knowledge with the context in which it is to be used is important in the encoding process, which then can lead to its appropriate retrieval; although text can describe context, the realism with which video can demonstrate context is one of its most powerful features (Hamilton & Taylor, in press).

The presentation of information has been given the greatest amount of attention in media and CAI design, although, as we have seen here, it is but one stage in the instructional process. A great deal of research has been done in this area, such as the extensive work in visual learning (Dwyer, 1972), text and screen design (e.g., Morrison, Ross, Schultz, & O'Dell, 1989), and human factors interface design (Rubinstein & Hersh, 1984; Hancock, 1987; Laurel & Mountford, 1990), which has resulted in useful guidelines. Due to the recent, rapid advancements in multimedia, however, most of this work provides little specific help to the multimedia designer/developer, although some principles do transfer to presentations of mixed media. For example, research in visual learning shows that the addition of visuals often helps comprehension of many different types of information. However, an increase in visual complexity (e.g., greater realism—photographs) in visual illustrations rarely helps in comprehension, especially in higher-order learning (Dwyer, 1972). This research can help in decisions about presenting high-end graphics using 24-bit color, which are costly in terms of system resources. These effects can vary according to learner characteristics (e.g., Canelos, Taylor & Gates, 1980). Of course, when deciphering visual complexity is an instructional objective—such as when biology students must identify details on a photomicrograph of plant tissue—the capability to display high image quality becomes a high priority.

Summary: Obviously, a great deal of existing research can inform the decisions regarding display devices in multimedia. As yet, however, there is very little research that applies specifically to key attributes of multimedia, such as the effects of mixing media, efforts at directing attention within the screen or screens, use of multiple versus combined screens, or other factors discussed here. This is primarily due to the fact that the field itself has only very recently come into existence; not only have researchers had little time to do research, but the rapid fluctuations of the field have made it difficult to set research priorities. Until relevant, specific research is performed and results in viable, useful guidelines, practitioners must rely on related research findings, experimentation and intuition.

Technological Factors

A Brief Technology Review

The increase in capability of the personal computer has been a story of sure and steady—albeit extremely rapid—progress in processing power, clock speed, bandwidth, etc., and computer users have watched on-screen displays change from all text with very simple monochrome graphics to photorealistic images and sophisticated audio-enhanced animation. The fundamental, ground-breaking changes, however, are most evident when we review the way that video has been associated with the computer display.

Managed Video vs. Integrated Video

In the early days of microcomputer-based interactive videodisc (circa 1980), an interactive video presentation was limited to two screens: a computer monitor for digital information (text and computer graphics), and a video monitor for a television signal, which was played back from a videodisc or videotape (Romiszowski, 1986, p. 384). Insofar as the video was concerned, the computer functioned as a primarily control device for finding and displaying either single video frames (as still images) or sequences of frames (as motion video) on the video monitor. From the beginning, there has always been an strong movement toward combining the two displays, but the fundamental differences between the computer and television signals—different scan rates, retrace and blanking speeds, bandwidths, overscan/underscan, etc.—made the marriage difficult. These technical differences are many and complex, and it is impossible to cover them here. Two solutions to this fundamental incompatibility of the two signals—either overlay boards or special monitors—allowed the computer signal to be superimposed over (but not actually mixed with) the television image. The epitome of this solution was the original IBM InfoWindow display system, which was actually a television and computer monitor combined within a single box and screen. As might be expected, such elaborate solutions added considerable cost to a microcomputer system, and the most affordable applications of interactive video continued to use the two screen system.

In the last few years, a number of engineering advancements, in the form of sophisticated yet affordable add-on boards, have advanced the merger of video with the computer system (Wells, 1989). These "desktop video" boards (ColorSpace IIi/FX, Targa boards, NuVista, etc.) offered several useful features, which could be grouped into three functional areas. They could digitize a single video frame (at various resolutions and color depths), which could then be stored and used in the same manner as a standard graphics file. Second, they could convert the computer signal—such as computer graphics and animation—into a television signal (NTSC) for output to videotape. Finally, some boards could superimpose the computer signal over a television image (by synchronizing or genlocking the two signals), and output an RGB or composite television signal, which could be recorded on videotape. These devices are intended to provide sophisticated television production capabilities to a video non-professional (thus their output of a television signal, and the term "desktop video"), as well as some limited incorporation of television images into a computer/digital format (Wells, 1989). The most sophisticated systems (such as Newtek's Video Toaster) provide the same capabilities (albeit of lower quality) of several separate, dedicated machines normally found only in broadcast-quality video editing facilities. To the extent that these boards produce a television signal as output, they run counter to the prevailing trend of multimedia , which is to incorporate all media into a single, digital format for display on a single monitor.

In all of these previously described technologies, the video signal must come from a conventional analog source (such as a VCR or a videodisc player) and tends to retain its fundamental identity as a separate, analog signal during its display or playback. This approach can be described as *managed* video (Arnett, 1990a & 1990b), in which the computer serves as a control device for a conventional external video source. The next step is *integrated* video, in which motion video is converted to digital form and then is treated as just another window on the screen, and managed in the same way as any other file type, like a graphics or text file. Such video can be manipulated (e.g., re-sized, re-edited, combined with other file formats) with software controls. There are currently two approaches to integrating (digitized) video in computer systems. Intel's DVI, which has been under development for the last few years, requires special hardware in the form of add-on boards to process and display video. On the other hand, software-only solutions, such as Apple's QuickTime offer greater simplicity of use and would seem to be the more highly integrated. Although a digitizing board is required to create QuickTime "movies" (video files), they can be played back on any Macintosh, without special hardware. At this writing, however, DVI provides the better image quality, as might be expected of a product with special hardware and a two to three year head start.

Problems and Pressures of Integration: Digital vs. Analog Video

The problem in integrating video into the computer system (in addition to the signal/display incompatibility mentioned previously) is the large amount of information in a television signal, combined with the relative slowness of the computer's data bus (its "bandwidth"). A single frame of raw, uncompressed video can requires as much as one megabyte of storage space, depending on the computer system. This file size has made it virtually impossible to store or play back motion video at a rate approaching "real time"—that is, at thirty frames per second. Even the fastest and largest hard drives cannot access and write such large files to the screen at this rate. For this reason, many developers are working on various forms of video compression, so that video frames can be stored in units much smaller than 1 MB. Complex algorithms are required to accomplish video compression, but fortunately two standards have already emerged. JPEG (Joint Photographic Expert's Group) is a high quality standard for compressing and storing single frames of video and is excellent for photorealistic stills such as slide images, but it requires too much disk space and bandwidth for motion video on personal computers. On the other hand, the algorithms used by MPEG (Motion Photographers Expert's Group), for motion video, compares information between successive frames so that similar information is not repeated. Although MPEG is not yet an official standard, many companies are working feverishly to incorporate these standards into their products (Arnett, 1990a & 1990b). For example, the first release of Quicktime uses JPEG for its still-frame capture, but does not yet achieve the MPEG standard for motion. On the other hand, DVI will support MPEG by late 1992.

Why is there pressure to convert all information into digital form? The answer is that digital data is the common denominator for all computer systems, and therefore vastly simplifies problems of storage, playback, transmission (over networks) and display. Similar tools can be used used to create, edit and display video as are currently used to create computer graphics or to edit text documents. When video, graphics, text and sound are simply different computer file types, development, delivery and display becomes vastly simplified. Storage and retrieval of all media in digital form, in addition to a technical simplification, promises integration of many different media into a single new medium: multimedia. Furthermore, only by conversion of video to digital form can it be made available over computer networks.

Technical Factors: A Matter of Trade-Offs

A fundamental premise in the world of computer interface design is that "There are no simple answers, only trade-offs" (Norman, 1987). Trade-offs can be defined as interrelated computer attributes that tend to draw on the same limited resources within a computer system: memory size, disk space, processing speed, transmission bandwidth, etc. For the multimedia designer, therefore, it is in fact impossible to freely mix media in courseware due to the inevitable limits on processing power and memory of the computer. A premise of this article is that developers must learn the limits imposed by the technical constraints of their hardware and software, so that they can best mix and match media to fit the instructional design while also following the most economic path within the technical constraints.

Norman (1987) has developed a quantitative comparison method, called trade-off analysis, which adopts the power function from psychological research. Briefly, this method computes User Satisfaction values for various attributes of the computer interface (i.e., disk access speed, image size, image quality, etc.), and then compares two interface variables graphically so that an appropriate compromise, or trade-off, can be selected. For example, user satisfaction with *image size* could be compared with user satisfaction with *time required to display an image* in order to obtain the most appropriate compromise, because improving either one requires substantial system power. In addition to giving confidence and justification for the necessary compromises in design decisions, this technique may show that a satisfactory compromise is not possible for different classes of users, such as experts and novices who must use the same system. The major criticism of this method, as Norman (1987) notes, is that there is currently little or no quantitative data available for user satisfaction, especially for variables in the brave new world of multimedia usage (e.g., what are the acceptable ranges for motion video frame rate, image size or resolution?). It would seem that acquiring measures of user satisfaction with various trade-off parameters for multimedia would be a useful and fruitful area of research. For the purposes of this article (and in keeping with the philosophy of the tradeoff analysis), it would seem sufficient to identify and isolate the key factors involved so that we may be aware of them. In so doing, we must realize that the usefulness and satisfaction with the entire courseware program/computer system will be due to the sum of its parts (Norman, 1987).

Prototypical Trade-Offs for Decision-making

Before considering specific technical factors that fit into the trade-off formula, it will be advantageous to consider two protoypical trade-offs that have recurred throughout the history of computing and are even more evident as multimedia becomes more prevalent. These can be described as *information versus time* and *convenience versus quality*. These two trade-offs can provide a framework for the kinds of choices that must be made when designing and developing multimedia courseware.

One of the more onerous aspects of working with computers is how systems slow down as a greater informational burden is placed upon them. A simple example concerns the integration of user-friendly devices such as menus, windows, and plentiful help screens. Although the progressive increase in computing power has

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made such devices a standard feature of personal computers, it was not so long ago that their use could be counted on to slow down systems considerably. It is ironic that the more user-friendly a computer system becomes, the slower it can be expected to operate; experts eschewed such programmatic helps in favor of lightning-fast responses, which required memorizing and inputting obscure, abbreviated keyboard commands. Such a trade-off is most noticeable in the display of increasingly realistic images. Only a few years ago, a monochrome diagram, composed of jagged squares, was the most we could expect in the way of graphics on a computer screen; today, near-photographic reproduction quality for still images, and television-quality motion video, are becoming the standards of multimedia. Displaying these kinds of graphics, however, has required the kind of storage space and horsepower that was available only on mainframes a decade ago.

Kay (1990) takes this notion one step further in describing a trade-off between speed-and-power vs. exposition-and-thoughtfulness, which relates to the use of artificial intelligence in interface design. Briefly, it may be preferable—yet more expensive in terms of system resources—to have a system that can adapt to the user's needs and can filter incoming data in order to supply more suitable information, rather than simply supply more information at a higher rate. The question is whether we want to build machines that are modeled more as intelligent personal servants, or as more powerful, faster engines. Again, there are no right or wrong answers; the correct soution depends on the needs of the specific situation. In the example at hand, multi-media will obviously require more system resources than a single medium. Yet, as Bruner and Olsen (1973) have noted, multiple media may be necessary in order to provide the variety of perspectives that different learners, with different skills and abilities, require to achieve a complete understanding of the underlying knowledge.

The great boon of media—especially multimedia—is its convenience. As every schoolchild knows by now, a videodisc is capable of storing 54,000 single images (which can be played back at 30 images per second to serve up 30 minutes of motion video), which is the equivalent of 675 slide trays, each holding eighty 35mm slides. This is a staggering statistic, but as anyone who has compared the image quality of a 35mm slide and a videodisc image (even displayed on the very best monitor) knows, the two are not the same. Much detail, sharpness, and subtleties of color are lost due to the limitations of the video signal. If we extend this line of thought, we can consider that the slide itself is a copy of a real scene (or a work of art, or a real object), then we are several times removed from the direct experience of the original. We may be able to store reproductions of reproductions of 54,000 works of art on a single piece of plastic, but what else have we lost by merely asking students to recognize reality rather than experience that reality? The result of this trade-off, which is most prevalent in computer-based multimedia, is to substitute representation for direct experience. The trap for which developers must constantly be aware, therefore, is not merely to use the power of multimedia to present more opportunities for representing reality—which is easy—but to give students more opportunities to experience reality in different ways. Simulations are a step toward this direction, but the challenge is use multimedia to create ever more powerful and realistic simulations. In order to counteract this tendency, instructional developers might use the computer as an auxiliary tool—for example, to interface with and analyze reality—and not always as the centerpiece of a presentation (Kay, 1991).

Current Technical Trade-offs

With these general trade-offs in mind, let us now look at the current state of constraints and see where we are and where we are heading. In general, a set of trade-offs within a given system means that a gain in one of these areas will result in a loss in another area, if all other system resources are held constant. Remember, these trade-offs are being discussed primarily from the viewpoint of the storage, processing and display of computer (digital) images. Analog video devices (such as laser videodisc and videotape) have similar/analogous constraints, but the technical specifications for analog video images are fixed by international standards and are much less variable than digital (e.g., 30 frames per second, 512 horizontal lines; vertical lines depend on the quality of the recording medium and the capture, transmission and display devices).

- **Resolution** is the apparent sharpness of the image as it appears on the screen. Images with high resolution appear sharper and crisper, with the result that details are more visible and easily inspected. Resolution is affected dramatically at each stage of the recording process, starting with the lens quality of the camera, through the quality of film or the tape format used for recording (Betacam vs. VHS), the type of transfer process from film to tape, and ending with the final display medium. In terms of program content, resolution can be relatively unimportant (a talking head), or extremely important (a microscope slide of plant cells or an x-ray radiograph).

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Resolution is a more subjective quality than it might seem. Experience shows that audiences will accept lower levels of image resolution unless there is a a side-by-side comparison with an image of higher resolution. For example, we know that VHS tape has the worst image resolution of any video medium, and is several orders of magnitude worse than projected 35mm motion picture film, yet audiences willingly embrace it because of the great convenience it offers (remember the convenience versus quality trade-off). The lesson to be learned here is to be careful about mixing similar image types with different resolutions on the same screen. However, side-by-side screens—one displaying video and the other digital data—could most likely have different resolutions if the audience has been conditioned and habituated to viewing specific types of information on each screen. This issue of "frame protocol" (Hannafin & Rieber, 1989), will be discussed later.

- **Image size** is a constraint in digitized images. Larger image size translates directly to more pixels, meaning larger file sizes and CPU processing requirements. This means, for motion video, that larger files must be retrieved, processed and displayed at a high rate. Some early versions of digitized motion video (such as Quicktime, as of this writing) look their best at only 1/16 normal screen size. However, this postage-stamp size results in an acceptable *apparent* sharpness, although this same image, if enlarged, would be seen to have very low resolution. Again, image size trade-offs do not affect analog video displays, since they are limited only by the display device (the size of the monitor screen or the power of the video projector).

Image size constraints will drive the choice and design of images displayed on the computer screen. If a small image is acceptable, then it should be used in the interest of conserving system resources. For example, a talking head or a close-up of some type of action (such as hands assembling a machine) will probably work well; however, a landscape or a large photomicrograph with significant detailed areas will not be acceptable in a thumbnail size. Videographers who record scenes for use in a window on a computer screen should keep the small size constantly in mind, just as motion picture cinematographers who made the transition to television many years ago were forced to change their habits of screen composition.

- **Color depth** refers to the number of colors that can be shown simultaneously on the screen at one time. The usual parlance refers to the size of the digital encoding unit for each pixel on the screen: 2-bit color allows 16 simultaneous colors, 8-bit color = 64 simultaneous colors, 16-bit = 64,000 colors, 24-bit = 16 million colors; 32-bit images allow the same color depth as 24-bit with the extra 8 bits providing accessory information. The trade-off, as in image size and resolution, is simple: more colors equals more data and a larger file size. Therefore, designers should use the smallest color depth (fewest number of colors) that is workable. For example, a talking head should not require 24-bit color, unless facial details are important. However, an art history expert may find even 24-bit color somewhat constraining, depending on the resolution of the monitor.

- **Speed** refers to the rate at which new frames can be displayed on the screen, that is, the refresh rate and the frame rate. Once again, speed is not an issue with analog devices, such as videodisc or videotape. True motion video requires thirty new frames to be written on the screen every second (NTSC standard). Standard QuickTime, for comparison purposes, can only manage about twelve frames per second, and with other trade-offs, the range can go as high a 15 or as low as eight or nine per second. DVI, on the other hand, normally plays at a full 30 frames per second, as befits a hardware-based system.

When video is recorded at 30 fps and must be played back at a reduced rate due to system constraints, two things can happen. If all frames are displayed, the action appears in slow motion and the result is not "real time"; or the computer skips frames in order to maintain "real time", the results appear jerky, especially if the frames are skipped intermittently. How does this choice affect design decisions? A talking head must be played back in real time in order to match the audio, but watching someone talk jerkily at 10 fps is rather disturbing. A designer would probably put speed of playback as a top priority for a talking head and sacrifice image quality and size. On the other hand, most graphic animations do not require playback at 30 fps. For purely economic reasons, many broadcast animated cartoons are in fact recorded as two (or three) frames of video or film for each graphic frame, which gives them an effective speed of 15 (or 10) frames for every second. Because these cartoons are so packed with action, our eyes tend to fill in the blanks. In this case, a slow speed is acceptable and resources can be re-allocated to increase color and resolution.

- **Data Rate and Bandwidth**—Data rate refers to the speed at which data is read from the storage medium, while bandwidth is a related factor that refers to the carrying capacity of the transmission channel used to transfer the data. Both parameters are therefore related to, but different from, the speed factor just described. For example, CD-ROM's are notoriously slow at reading data, and for this reason cannot currently be used for direct playback of uncompressedvideo, despite their tremendous storage capabilities. Networks also tend to be bottlenecks for transmission of large files, such as video, at a fast enough rate for suitable display of motion.

Summary

When choosing a display format for interactive multimedia, the decision about how and whether to mix analog and digital images is fundamental, as is the decision about whether to use managed or integrated video. Managed video is the current norm, and the simplest method is to keep the analog display separate from the digital display. An added level of complexity and cost is required to overlay the computer signal on the video display. True integrated video requires conversion of the analog source to digital, and adequate storage and processing power for retrieval and display. Once the important technical constraints of any computer-based multimedia system are understood and delineated as interrelated trade-offs, it will be easier to make decisions regarding the components of computer system. It may be helpful to remind ourselves that most system constraints tend to level off as the technology advances (e.g., storage capacities, processing power, transmission bandwidth). All trade-offs, except for the prototypical trade-offs that tend to be endemic to computer systems in general, tend to become less constrictive as time goes on.

Practical Considerations

System requirements and constraints, and the theoretical factors that affect learning, are important matters that should concern anyone who has the responsibility for designing and developing a multimedia display system. The following section is intended to address the more practical matters that will determine the actual configuration of a workstation or a group of workstations in a particular context

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. Some of these considerations are direct implications of previously-described technical and theoretical factors.

1. An single screen system that incorporates analog video with computer overlay is typically more technically complex (and therefore more expensive) than a two-screen system, despite the requirement for an extra, video-only monitor. However, single-screen systems that use integrated (digital) video can be much simpler, except that they now require more powerful computers and very large storage capacities (i.e., hard disks in the gigabyte range, CD-ROM drives, high-capacity tape drives), or networks with high-bandwidth capabilities (e.g., Ethernet).

2. Two-screen systems are simpler to control from a programming standpoint than single-screen managed-video systems. For example, a Macintosh two-screen system requires only a single cable and minimal software (e.g., Hypercard) in order to provide complete control of a videodisc player. However, integrated systems show promise of also being very easy to control; for example, Hypercard can be used to control Quicktime movies with a minimum of complexity.

3. Altering single screen, managed-video courseware programs (computer graphics overlaid on video) will probably be more problematic than altering programs that have kept the two media separate (dual screen). However, single screen integrated-video designs will ultimately offer greater flexibility for modification.

4. Two-screen systems will require more physical space (for the second monitor, as well as for the video source device, probably a videodisc player).

5. Two screen systems have twice as much physical display (screen) space for presenting information. They can present different levels of image quality without disturbing the viewer, as would be the case if different quality levels are mixed on a single screen.

6. Two-screen systems require observing a more complex and uniquely defined *frame protocol,* which is defined as the "systematic use of available screen space for defined purposes" (Hannafin & Rieber, 1989). Also, a cardinal principle of

interface design is consistency (Rubinstein & Hersh, 1984), and a second screen compounds the problem of consistency of use.

7. Two screen systems may require stronger and more frequent and elaborate cuing, so that students will know when and where to direct their attention to the second screen.

8. Two screen systems will offer new opportunities and greater flexibility for varied or learner-control system uses. For example, the video screen could be used as a television monitor, or as a stand-alone monitor for a hand-controlled (or bar-code controlled) videodisc player. Likewise, depending on the capabilities of the computer system, the computer could be used alone with the same capabilities as a single-screen, all-digital multimedia platform.

The decision about which hardware configuration to purchase will depend on a combination of factors, based upon theoretical, technical and practical considerations. It is to be expected that no system will be a perfect match, and that compromises must be made. Remember that "there are no simple answers, only trade-offs" (Norman, 1987).

Decisions Affecting the Plant Biology Multimedia Workstation: A Case Study Outline

Recently, the author and his colleagues were required to make decisions about the hardware for multimedia student workstations to be used in a sophomore-level plant biology laboratory. The following is an outline of the requirements prioritized into two categories, based on course objectives.

Important requirements:

- Highest possible resolution, color rendition, and image size for graphic and photographic images
- Storage for a large number of images (photographs, animations, still pictures, etc.)
- Create and maintain a database of images that could be accessed apart from the computer system (i.e., with hand controller or bar code, as a classroom display or for individual use in a media carrel)

- Moderate need for real-time motion video
- Fairly low-cost system
- User-friendly, easy-to-learn system
- High system speed (no long waits for system to write a graphic to screen or respond to user input)
- Variety of software: simple database of images; classic self-instructional tutorials; several simulations; some computer-based tools, such as cladistic programs, word processors, etc.
- Flexibility to use a variety of different courseware at various levels of interactivity, some of which has not been identified (e.g., Level 1 and 2 videodiscs; computer tools, such as word processors and various scientific programs)

Less important requirements:
- User manipulation of realistic (video) images
- Complete integration of text and images (i.e., images can be satisfactorially used as illustrations of text)
- Conservation of physical space (i.e., extra equipment is not a problem)
- Maintaining of all information in digital format
- Frequent updates of visual image bank

System Configuration

The final decision favored a classic two-screen system, in which the computer (Macintosh IIsi with a high-resolution monitor)controls the videodisc player (Pioneer 2200 with a high-resolution video monitor). Although there is a relatively high cost involved with updating a visual database that is stored on videodisc, image quality requirements, system flexibility and the current flux and uncertainty in digital video presentation and storage dictated the choice of this design.

Coincidentally, this dual screen arrangement matched certain skill patterns that students of biology must develop: finding and matching details on diagrams to realia, or real-life objects (i.e., matching parts of a diagram of a tissue to a section of tissue on a microscope slide or a photomicrograph). This carry-over of skill patterns helped us to specify a consistent design feature, or screen protocol, that we tried to maintain throughout the program: restrict the computer screen to symbolic information (text, diagrams, etc.) and the video monitor to realistic images and highly detailed graphics.

On the surface, the decision in favor of a two-screen system may seem to run counter to the trend toward single integrated systems; yet it maintained the required system flexibility and freed the computer to perform those things that a computer does well. It also maintained an acceptable system speed for a relatively low-cost system (Macintosh IIsi) with a user-friendly interface, and yet allowed for a high degree of interactivity.

References

Arnett, N. (1990a, October 15). Handling motion video. Multimedia Computing & Presentations. Multimedia Computing Corp., Santa Clara, CA. pp. 5-7.

Arnett, N. (1990b, November 23). Motion video misconceptions. Multimedia Computing & Presentations. Multimedia Computing Corp., Santa Clara, CA. pp. 5-8.

Ausubel, D. P. (1963) The Psychology of Meaningful Verbal Learning: An Introduction to School Learning. New York: Grune & Stratton.

Ausubel, D. P. (1977) The facilitation of meaningful verbal learning in the classroom. Educational Psychologist, 12, 162-178.

Bruner, J. S. & Olson, D. R. (1973). Learning through experience and learning through media. In G. Gerbner, L. Gross, & W. Melody (Eds.), Communications Technology and Social Policy: Understanding the New "Cultural Revolution" (pp. 209-227). New York: John Wiley & Sons.

Canelos, J. J., Taylor W. D., & Gates, R. D. (1980). The effects of three levels of visual stimulus complexity on the information processing of field-dependents and field independents when acquiring information on performance on three types of instructional objectives. Journal of Instructional Psychology. 7, 65-70.

Cennamo, K.S., Savenye, W.C., & Smith, P.L. (1991). Mental effort and video-based learning: The relationship of preconceptions and the effects of interactive and covert practice. Educational Technology Research & Development. 39(2), 41-49.

DeBloois, M. (1987, April). Anticipating compact disc-interactive (CD-I): Ten guidelines for prospective authors. Educational Technology. 27(4), 25-27.

Dwyer, F. M. (1972). A Guide for Improving Visualized Instruction. State College, PA: Learning Services.

Dwyer, F. M. (Ed.). (1987). Enhancing Visualized Instruction—Recommendations for Practitioners.

Gagne, R. M. (1985). The Conditions of Learning and Theory of Instruction (4th ed.). New York: Holt, Rinehart and Winston.

Gagne, R. M., & Briggs, L. J. (1979). Principles of Instructional Design (2nd ed.). New York: Holt, Rinehart and Winston.

Hamilton, R. H., & Taylor, C. D. (in press). The use of schema theory in the design and development of an interactive videodisc module: A medical example. Canadian Journal of Educational Communication.

Hancock, P.A. (Ed.) (1987). Human Factors Psychology. Amsterdam, Netherlands: North-Holland.

Hooper, S. & Hannafin, M. J. (1988). Learning the ROPES of instructional design: Guidelines for emerging interactive technologies. Educational Technology. 28 (7), 14-18.

Hannafin, M. J. & Phillips, T.L. (1987). Perspectives in the design of interactive video: Beyond tape versus disc. Journal of Research and Development in Education. 21(1), 44-60.

Hannafin, M. J., Phillips, T.L., & Tripp, S.D. (1986). The effects of orienting, processing and practicing activities on learning from interactive video. Journal of Computer-Based Instruction. 13 (4). 134-139.

Hannafin, M.J. & Rieber, L.P. (1989). Psychological foundations of instructional design for emerging computer-based instructional technologies: Parts 1 and 2. Educational Technology Research & Development. 37(2), 91-114.

Hanson, L. (1989, October). Multichannel learning research applied to principles of television production: A review and synthesis of the literature. Educational Technology. 27(4), 15-9.

Jonassen, D. H. (Ed.). (1988). Instructional Designs for Microcomputer Courseware. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kay, A.C. (1991, September). Computers, networks and education. Scientific American. 237 (3). 138-148.

Kahneman, D. (1973). Basic issues in the study of attention. In D. Kahneman (Ed.). Attention and Effort. New York: Prentice-Hall, pp. 1-12.

Klatzky, R. L. (1980). Human Memory (2nd ed.). New York: W. H. Freeman & Co.

Kozma, R. B. (1991). Learning with media. Review of Educational Research. 61 (2), 179-211.

Laurel, B. & Mountford, S.J. (1990). The Art of Human-Computer Interface Design. Reading, MA: Addison-Wesley.

Locatis, C., Charuhas, J., & Banvard, R. (1990). Hypervideo. Educational Technology Research & Development. 38(2), 41-49.

Mayer, R. E. (1979). Twenty years of research on advance organizers: Assimilation theory is still the best predictor of results. Instructional Science, 8, 133-167.

McCluhan, M. (1965). Understanding Media: The Extensions of Man. New York: McGraw-Hill.

Morrison, G.R., Ross, S.M., Schultz, C.W., & O'Dell, J. K. (1989). Learner preferences for varying screen densities using realistic stimulus materials with single and multiple designs. Educational Technology Research & Development. 37(3), 53-60.

Norman, D.A. (1976). Attention, effort and resources. In D. Norman (Ed.), Memory and Attention. New York: Wiley, pp. 63-81.

Norman, D.A. (1987). Design principles for human-computer interfaces. In Berger, D., Pezdek, K., & Banks. W. (Eds.), Applications of Cognitive Psychology: Problem-solving, Education and Computing. Hillsdale, NJ: Erlbaum.

Paivio, A. (1979). Imagery and Verbal Processes. Hillsdale, NJ: Lawrence Erlbaum Associates

Poole, L. (1991, September). Quicktime in motion. MacWorld, 154-159.

Reiser, R. A., & Gagne, R. M. (1982). Characteristics of media selection models. Review of Educational Research. 52 (4), 499-512.

Rieber, L.P. (1990). Animation in computer-based instruction. Educational Technology Research & Development. 38(1), 77-86.

Romiszowski, A. J. (1986). Developing Auto-Instructional Materials. London: Kogan Page.

Rubinstein, R., Hersh, H.M. & Ledgard, H. F. (1984). The Human Factor: Designing Computer Systems for People. U.S.A.: Digital Press.

Salomon, G. (1979). Interaction of Media, Cognition and Learning. San Francisco: Jossey-Bass.

Salomon, G. (1984). Television is "easy" and print is "tough": The differential investment of mental effort in learning as a function of perceptions and attributions. Journal of Educational Psychology, 76, 647-658.

Salomon, G., & Gardner, H. (1986). The computer as educator: Lessons from television research. Educational Researcher, 15 (1), 13-19.

Wells, M. (1989). Desktop Video. White Plains, NY: Knowledge Industry Publications.

Whitehead, A. N. (1929). The Aims of Education. New York: MacMillan

Wright, J., & Huston, A. (1983). A matter of form: Potentials of television for young viewers. American Psychologist, 38, 835-843.

Title:

The Nature, Function and Value of the Curriculum Materials Center on Colleges of Education

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THE NATURE, FUNCTION AND VALUE OF THE CURRICULUM MATERIALS CENTER IN COLLEGES OF EDUCATION

Background

The curriculum material center (CMC) is an area typically located in a college of education building. Such a center usually provides a full range of printed and non-printed materials, equipment, and delivery of support services to faculty, students, and teacher education programs in a college of education.

The primary mission of the CMCs involves many processes in respect to what students and teachers do with materials evaluation, synthesis, reflection thinking, appreciation, and assembling of materials (Ward & Beacon, 1973, p. 31). Albright (1989) pointed out that an additional mission of a curriculum material center is "to help college faculty members improve their teaching." In addition, they need help in such activities as "course planning, discussion, diagnosing student misunderstandings of course content, writing tests, and course evaluation" (p. 41). The CMC is valuable to teacher education programs as they function to select, house, and make available new materials. According to Vlcek & Wilman (1989), the basic purpose of curriculum material centers is "to develop teaching/learning strategies, programs, and materials that facilitate learning of training performance" (p. 11). The personnel serving in the CMCs ought to provide professional directions and guidance to center clients. Curriculum material center personnel ought to be trained to keep apace with advancement of the modern technology. Teacher education institutions must support their CMCs "so that the quality of their service will enhance the over all teacher education programs" (Ellis, 1969, pp. 31).

Curriculum material centers exist to facilitate and improve learning by supporting classroom instruction as well as supporting services to student teachers, staff, faculty, and the community. The curriculum materials center ought to be an organization that is charged with the responsibility of facilitating the continuing development of professional and personal competencies of faculty, particularly those that lead to the improvement of teaching and learning (Albright, 1983; Gaff, 1975).

The Statement of the Problem

There are justified demands for current information concerning organizational structure, management processes, funding, and perceptions related to the relation of CMC's as it functions and value in the preparation of teacher education programs. This study attempted to identify the relationship between the existence of the CMC's and

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the effects of accreditation and standards upon CMC's, and the factor which represents the greatest barrier to the efficient and effective integration of the CMC's into the respective teacher education programs. This study is limited to 103 colleges of education in selected institutions in nineteen (19) states representing the membership of the North Central Association (NCA). They are Arizona, Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, South Dakota, West Virginia, Wisconsin, and Wyoming.

This study compared and analyzed the perceptions of the CMC coordinator/directors and the administrator/dean regarding the functions and value of the CMC's in the context of the present and the future. The study was designed to produce a profile of curriculum material centers and their relation to the organization of colleges of education and the respective teacher education programs. The thrust of the study was 1) to determine the purpose of the centers, 2) to determine the impact of these centers upon the teacher education programs within the colleges, 3) to identify patterns or profiles of the organization and management of the centers, and 4) to determine whether the CMCs are maintained because of political tradition, i.e., to meet the requirements of external agents such as NCATE, or are these units necessary to the effective preparation of future classroom teachers at the teacher training level. The basis of these four concerns were set within a view of perceptions of the present context versus future status of the CMC's in the colleges participating in the study.

Significance of the Study

It was anticipated that the results of the research would provide current insight as well as extensive information into the nature and the "status quo" of CMC's, as well as probable futures for such centers. This study would: 1) provide pertinent information to educational administrators for use in planning and managing more efficient and effective CMC's, in an administrative component of colleges of education in the present and the future; 2) obtain data regarding staff, media services, facilities, the scope of print, non-print and equipment collections in the present and future context; 3) determine strategies for developing instructional media support via the CMC as a primary and integrated factor in the implementation of teacher education programs; and 4) provide a profile of the effects of NCATE, as those standards relate to the continued acceptance and existence of CMC's within colleges of education; 5) the development of a media management model which should promote a more efficient and effective planning process and integration of CMC's in teacher education programs, including pre-service and in-service.

The results of the study is significant in that it brings together a number of administrative and organizational structures that were found in the CMC's from which the data were obtained. These patterns could be used for the justification of CMC's status of staff and personnel, facilities and services, and the selections of material holdings, equipment, and administrative control, for the present as well as the future.

Design of the Study

Thirteen hypothesis were developed from four research questions. In addition, hypotheses were formulated to determine whether the justification for the curriculum materials centers was to meet accreditation requirements or to facilitate and improve K-12 teacher preparation. There were no ready-made questionnaires suitable for this study. As a result, the instrument used for this research was self-designed questionnaire.

A 27-item questionnaire for the CMC coordinators/directors and a 15-item questionnaire for the college executives was developed. Comparison of mean scores, t-scores and pearson correlation coefficients treatments were used for the analysis of the data.

After considering various methodologies which could be used to meet the study objectives, the survey technique was selected for use in this study. The survey technique was employed to gather data concerning the current and future status of the CMC. Two types of instruments were employed; descriptive methodology and a Likert scale format. The descriptive survey technique was employed to gather data concerning the existing status of the CMC's. The Likert scale format was selected for the survey instrument because it is reliable and can be suitable to people with a particular attitude. The items of the questionnaire were rated on a scale of one to five(1- 5), with designations such as "strongly disagree, disagree, undecided, agree, to strongly agree."

Population and Sample

The universities and colleges considered for this study were selected institutions which prepare elementary, middle and secondary school teacher candidates in 19 states representing the membership of the North Central Association. All together, 103 institutions were selected. The target population of this study consisted of four groups: the CMC coordinator, the college executive of large colleges with an enrollment of 10,000 or more, and smaller colleges with an enrollment between 3,000 to 9,999. The population was composed of 206 participants, 103 CMC coordinators and 103 college executives. The findings of this study were based upon 81 percent rate of responses from the CMC's college executives and 79 percent from coordinators.

Analysis of Data

After the data was collected, all items were prepared and arranged for examination. The t-test treatment was used to compute the difference between the two means (Norusis, 1987, stated that such an analysis is appropriate for such data).

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While Pearson's correlation coefficient was chosen due to the equal interval nature of the data, Hinkle, Wiersma, and Jurs (1979) stated that Linear regression analysis was appropriate for such data. In addition, descriptive statistics were presented due to the nominal nature of the responses. Hinkle, Wiersma, and Jurs (1979) stated that such an analysis is appropriate for such data). SPSS-X for IBM/CMS, at the University of Toledo was used to analyze the data.

The Results of the Study

Hypotheses were formulated to determine whether the justification for curriculum materials centers (CMC) was to meet accreditation requirements or to facilitate and improve k-12 teacher preparation. The results revealed that college executives differ in their perceptions in regards to the standards and requirements of NCATE. However, as the results of this study demonstrated, the college executives very strongly believed that CMC's exists in response to the pressure to meet the needs of pre-service teacher preparation programs. On the other hand, CMC coordinators very strongly believed that CMC's exist to meet the standards and requirements of NCATE.

Further, the college executives and the coordinators differ in their perceptions in regards to the instructional support and budget. The college executives suggest that the CMCs were not provided with adequate funding to carry out their mission in the present. However, the college executives predicted that the CMC of the future will be provided with appropriate funding and instructional support to carry out the mission of this support center. The college executives predicated that the CMC of the future will be provided with appropriate funding and instructional support to carry out the mission of this support center. The coordinators, on the other hand, were pessimistic about funding and instructional support in the present and the future. However, the data indicated the CMC coordinators of the smaller institutions were presently doing well in respect to instructional support. Lastly, both college executives and CMC coordinators agreed that the CMC should be evaluated in terms of the center's impact upon the success of the respective teacher education programs in the colleges of education, as opposed to traditional library circulation evaluation models.

The descriptive profiles of the CMCs in both small and large institutions of higher education produced the following information highlights:

1. The lines of authority were controlled by the college of education.
2. The staff and personnel in the curriculum center ranged from one or two professional staff members, and from one to two support staff personnel. The number part-time student assistants ranged from 8 to 10.
3. Generally, the materials and equipment collection of the CMC was purchased by the college of education.

4. Curriculum materials centers were budgeted as part of the college of education or department of education.
5. A clear majority of the management operations in the large institutions were generally computerized, while fewer management operations in smaller institutions were computerized.
6. A high majority of the large institutions provided *pre-service* teacher education classes/workshops on a regularly scheduled basis in the curriculum material center. Yet, only a small portion the above services were provided to the *in-service* teachers. However, a clear majority of the smaller institutions provided the noted services to both *pre-service* teachers and *in-service* teachers (see Table 1 &2).
7. Statistically, the major clients of the CMC were undergraduate students in teacher education. The other identified clients were graduate students and faculty in the college of education.
8. The following services were provided to the clients of the CMC: production of inexpensive classroom instructional materials, video (facilities/equipment, microteaching and previewing); computers (microcomputers) for client use; and at a lower level, photographic services.
9. Curriculum material centers maintained standard collections of traditional A-V equipment, textbooks (K-12), periodicals (K-12), periodicals (teacher education), and curriculum guides (K-12).

TABLE 1

Pre-service Teacher Education Classes/Workshops
Regularly Scheduled in the Center

	Small Institutions Percent	Large Institutions Percent	All Institutions Percent
Are *Pre-service* teacher education Classes/workshops regularly scheduled and held in the CMC using the facilities, equipment and services of the Center.			
Yes	63.6	80.4	73.4
No	36.4	19.6	26.6

TABLE 2

In-service Teacher Education Classes/Workshops Regularly Scheduled in the Center

	Small Institutions Percent	Large Institutions Percent	All Institutions Percent
Are *In-service* teacher education Classes/workshops regularly scheduled and held in the CMC using the facilities, equipment and services of the Center.			
Yes	54.5	39.1	45.6
No	45.5	58.7	53.2
No Response	0.0	1.0	1.3

In determining the significant barriers to change facing institutional planners related to the future of CMCs, the study found positive correlation between college executives and coordinators. Table one lists the perceptions of the college executives and CMC coordinators as related to the factors representing the greatest barriers. The ranking order of the barriers were as follows (1 = the greatest barrier and 9 = the least difficult barrier). Clearly, the most difficult problem for CMCs in the future is to obtain and retain administrative support to continue their existence.

TABLE 3

The mean Perceptions of the College Executives and CMC Coordinators as Related to the Factors Representing the Greatest Barrier.

Factors With the Greatest Barrier	Rank
Space	3
Qualified staff (Professional and Support)	5
Leadership by Coordinator/Director	8
Acceptance by students	9
Institutional Administrative Support	1
Faculty involvement	2
Organizational structure	6
Impact of new technologies of instruction	7
Adoption of new technologies of instruction	4

Pearson Correlation Coefficient = .63

Implications

Curriculum materials center directors must collect better data to identify and present the CMC needs to institutional decision makers. Given the current view of the future trends for curriculum material centers, the following implications are presented:

- The primary concern is the lack of communication between the college executive and the curriculum material center coordinators. Regular meetings between deans and CMC directors must take place to promote better communication and change. In addition, the appointment of curriculum material center directors to deans' administrative decision-making groups may improve communications and institutional planning.
- The management plans and operational services of the CMC should be reviewed by an advisory committee which ought to include faculty representatives from each of the respective teacher education areas. When such a representative group helps establish priorities, it makes it possible for the curriculum material center coordinator to plan and implement suggestions originating from within the programs of the department or the college.
- It appears to be reasonable and necessary that colleges of education ought to provide pre-service and in-service teachers a wide range of training experiences and to introduce them to the use of all types of instructional materials and new technologies of instruction.
- As curriculum material centers grow and accommodate more pre-service and in-service teachers as well as faculty of the college of education, it will become increasingly more difficult to justify needs, establish policy, budget, and manage staff without goals, objectives and criteria by which to measure or evaluate the performance of this organizational unit. Rationally, it seems that what is needed is for CMCs to move from traditional circulation based evaluation to models which are more programmatically based.
- Given the perceived barriers to change, deans and directors must work together on strategic planning in order to guarantee the integration of the curriculum material center into the future of the college.
- In comparing the descriptive profiles reviewed in Teclehaimanot (1990) and Ellis (1969), the following factors remain a problem for the curriculum material center:
    a. the organizational structure of curriculum material centers has not changed to reflect the needs of modern institutions of higher education.
    b. modern CMCs have been highly affected by new technologies of instruction.
    c. aspects of the management of current curriculum material centers are being computerized at various levels of sophistication.
    d. adequate funding and institutional support remains a major problem for CMCs.
    e. the leaders of curriculum materials center in the 1990s must be pro-active and seek the funds to purchase equipment and materials rather than relying upon

donations by producers and publishers.

The major findings of current research strongly suggest that the curriculum material center coordinators and the college executives (deans or designers) need to collaborate, plan and clarify their respective values related to the CMC and NCATE standards. Further, different perceptions regarding the nature and function of curriculum material centers continue to exist.

Bibliography

Albright, M. J. (1983). The status of media centers in higher education. Washington, D.C. : Association for Educational Communications and Technology,

Albright, M. J. (1989). It's time to rethink instructional technology services in higher education. Tech Trends, 34 (5), 40-45.

Ellis, E.V. (1969). The role of the curriculum laboratory in the preparation of quality teachers. Tallahassee, Florida: Florida A & M University Foundation.

Gaff, J. G. (1975). Toward faculty renewal. Washington: Jossey-Bass.

Teclehaimanot, B. (1990). The nature, function and value of the curriculum materials center in colleges of education. Unpublished doctoral dissertation, the University of Toledo. Ann Arbor, Michigan: University Microfilms, No. 91-04088.

Vlcek, C. W. & Wiman R. V. (1989). Managing media services: Theory and practice. Englewood, California: Libraries Unlimited, Inc.

Ward, P. L. & Beacon, R. (1973). The school media center: A book of readings. Metuchen, New Jersey: The Scarecrow Press, Inc.

Title:

Multiple Feedback Mechanisms in a Business Simulation

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Introduction

For the last two years, we have been developing computer-based business simulations to help prepare high school students for entry-level jobs in business settings. In designing our simulations, we wanted to augment the simulated environment with additional instructional supports to bolster and focus student learning. Feedback mechanisms were seen as appropriate pedagogical tools, but ones that had to be used carefully to avoid destroying the seductive and instructional power of the simulation fiction. Unfortunately, the research literature was largely silent about the use of feedback mechanisms for simulations. The feedback mechanisms we developed were based on three principles. First, feedback mechanisms should support the user's intuitions about being a part of the simulation fiction. Second, feedback mechanisms should clarify misunderstandings and strengthen previous learning. Third, feedback mechanisms should help the learner generalize to similar situations. This paper explores the rationale and implementation of our feedback mechanisms to help other simulation designers think about these issues in their designs and to generate ideas to help form a research agenda on simulation feedback.

Why Simulations?

As any educational technologist knows, different instructional media are appropriate for different instructional needs. In preparing high-school students for entry-level jobs, we choose to utilize simulations because we felt that simulations would:

1. Provide a Learning Context

   High-school students get very little exposure to realistic business settings. By providing them with experience in a simulated business setting, students would gain an experiential understanding of that world.

2. Integrate Disparate Topic Areas

   One of the major weaknesses of the traditional classroom is that topic areas become artificially separated. For example, marketing and accounting are taught in separate classes. Because real-world businesses have to deal with many issues simultaneously, good business simulations force students to integrate different topic areas in realistic ways.

3. Demonstrate the Realistic Contingencies of the Workplace.

   At a minimum, simulations provide a realistic view of the cause and effect relationships in a particular environment. So for example, users of a business simulation will learn that if customers are treated poorly, revenues and profits will drop.

4. Motivate Students to Learn Basic Skills

   By being introduced to a realistic workplace, students will become more motivated to learn basic skills that are valued in the workplace (i.e., math, writing, presentation).

5. Show How Every Employee is Important to Business Success

   By getting a feel for how different functional areas must work together to make a business organization a success, students will learn how each job and each employee is vital to the health of any organization they might join.

6. Empower Students

   By putting the students in the role of the general manager and giving them decision-making authority and responsibility, students become energized to take control of their own careers.

7. Elicit Critical and Creative Problem-Solving Skills

   By practicing decision-making and seeing how different decisions have different, yet predictable, results, students learn the importance of critical analysis and creative problem solving.

Why Simulation isn't Enough

The simulation we've described in the seven points above could be designed to simply mirror the reality of a typical business environment. It would present the cause and effect relationships found in the real world and students would move through its simulated environment and attempt to discover these relationships. For example, by treating customers poorly several times in the simulated world, students are likely to discover that this type of action lowers revenues.

Unfortunately, a simulation that simply presents an analog of the real world will suffer from the same limitations the real world has in playing the role of educator. As people move through the real world they often fail to learn important relationships (e.g., shaking hands can spread the common cold), they often fail to put their knowledge into practice (e.g., washing hands before eating), they often learn things incorrectly (e.g., they learn that vitamin C prevents colds when it actually only lessens the severity of colds), and sometimes they even "learn" things that aren't true (i.e., superstitious behaviors).

Because experience really isn't the best teacher, we wanted to add mechanisms to our simulations to clarify and bolster student learning. We thus turned to the notion of feedback.

The Nature of Feedback

In its simplest form, feedback can be represented in the following way:

Organism's Action—— *followed by* —— Environmental Event

Feedback is some environmental event that follows an organism's action and can be used by the organism to evaluate the effects of its action. For example, a child who is scolded for making noise is receiving feedback that creating too much noise will lead to scolding and is an undesirable behavior.

Ever since human beings evolved to the point where they intentionally and systematically prepared their young for future roles in life, parents and other adults have utilized feedback to mold the behavior and clarify the knowledge of learners. When three-year olds approach an open fire or electric socket, parents provide feedback by yelling "stop." When one of these same three-year olds points to the postman and says "Dada," mother responds by saying, "No, that's the postman; daddy is in the kitchen."

Feedback doesn't have to be an intentional instructional event. As we mentioned earlier, the real world can provide feedback itself. The child who puts her hand in a candle's flame will get feedback that flames cause pain.

Because of the limitations of real-world learning, educators and parents use feedback to help learners avoid harm and speed the learning process.

The Research on Feedback

Despite feedback's long history, there is still confusion about how, when, and in what learning contexts to use it (Carter, 1984; Cohen, 1985). This is especially true in regards to uses of feedback in educational technology applications (Clariana, Ross & Morrison, 1992). Questions regarding the timing of feedback (e.g., immediate vs. delayed; Kulik & Kulik, 1988; Smith, 1988; Sturges, 1978), the control of feedback (e.g., student vs. external control; Sales & Williams, 1988; Belland, Taylor, Camelos, Dwyer and Baker, 1985), the effect of the type of material to-be-learned (e.g., high vs. low cognitive load; Sales, 1988), and the effects of individual differences (e.g., locus-of-control, ability, sex; Clariana & Smith, 1989; Schimmel, 1988) make it difficult to offer a clear prescription on the proper utilization of feedback. In fact, even the primary effect of feedback is unclear. Some theorists emphasize the motivational influence of feedback, while others focus on the informational aspects (see Sales, 1988).

Despite the confusion, there are several overall guidelines that have been put forth based on the research on feedback (Carter, 1984; Cohen, 1985; Viau & Clark, 1987). First, feedback should generally be informative rather than motivational. Second, feedback for simple cognitive material should be administered immediately. Feedback for higher-level cognitive material should be delayed. Third, in most situations feedback should be just informative enough to provide knowledge of the correct response. However, when students make an incorrect response or the material is more cognitively demanding, they should be given more elaborate explanatory feedback. Fourth, for more advanced students, who may get frustrated with too much irrelevant 'noise,' feedback should be less extensive and more often delayed. Students of lesser achievement should be given knowledge of correct response, perhaps with additional motivational support; more elaborate feedback often overwhelms low ability students (Clariana & Smith, 1988). Fifth, in some situations it may be helpful to give students the option of receiving feedback.

Unfortunately, none of the research that generated these guidelines used comprehensive educational simulations as the instructional intervention. In fact, most of the work above uses rather simple or short educational interventions that differ significantly from the approach taken in simulations. Obviously, simulation designers will want to be cautious in utilizing this literature. Nevertheless, given that simulations present complex situations, the research might suggest that delayed and elaborate feedback be used. In the discussion below, this prescription is reinforced, though for different reasons than simply the complexity of the material.

Note that the dearth of empirical research on simulation design issues is not limited to the area of feedback mechanisms. As Reigeluth and Schwartz have noted from their review of the literature, "few empirically based prescriptions have been offered to guide the design of instructional simulations" (Reigeluth & Schwartz, 1989; p. 2). This lack may be indicative of the holistic nature of simulations and the fact that simulation design (i.e., creating a mimetic world) is more art than science.

Overview of the Project

In order to understand the rationale and operations of our simulation feedback mechanisms, an overview of the project is necessary. This is especially true because we don't implement our simulations as isolated instructional events. Rather, they are part of a larger, integrated educational program. Thus, our feedback mechanisms take many forms and are provided by many different instructional components.

The Classroom, Inc. Project is a collaborative effort of the New York City Public Schools, Morgan Stanley & Co., Inc., and Teachers College, Columbia University[1]. The overarching goal of the project is to prepare high school students for entry-level jobs in business settings, while increasing their future educational options. The project utilizes computer-based business simulations as an instructional anchor for student learning and as a logistical anchor for three other project components: mentorships, summer internships, and curriculum enhancements (See Appendix A).

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[1] Funding for the Classroom, Inc. project was made available through grants from Morgan Stanley & Co., Inc., The Morgan Stanley Foundation, The Mariposa Foundation, Louis Calder Foundation, Bear Stearns & Co., The Loews Foundation, Andrew W. Mellon Foundation, American Express, and Chase Manhattan Bank.

Two business simulations have been developed: a service industry simulation (i.e., a hotel) and a manufacturing business (i.e., a clothing manufacturer). Each simulation has a total running time of about 10 hours for its computer-based component and is supported by other instructional activities so that the total instructional intervention for each simulation is spread over an 18-week semester, utilizing about 60 hours of instructional time (See Appendix B and C).

Each computer simulation utilizes the Windows 3.0 environment and Asymetrix's Toolbook development platform to combine graphics and text into a user-dominated exploration of the simulated business environment.

The instructional events and activities augmenting the simulation are crucial to the success of the simulation as a learning tool. We now describe each of these in detail:

1. Topic Introductions

   The simulation is preceded by class time that introduces the major topic areas to be covered in each simulation module. Teachers can organize this class time in any manner they think will be most effective. Note that major topic areas are delineated from the list of learning objectives. To give an example, Module 1 might focus on the Management and Marketing learning objectives.

2. What-if Analysis

   In each session of the simulations, students have to make numeric decisions, such as setting the price of a hotel room or determining how much to pay the housekeeping staff. To help the students understand the issues involved in making such decisions, a pre-programmed, what-if analysis spreadsheet is available. Students use this for a whole class period at the beginning of each module.

3. Simulation Play

   In teams of three or four, students play the role of the general manager of the simulated enterprise. Each simulation session runs 30 minutes, representing six months of simulated time. At the end of each simulated year—every two sessions—students get a printout of their financial reports, a status report, and text-based feedback on each multiple-choice decision they made.

4. Teacher-Guided Discussions

   After the students play the simulation for two contiguous days, the teacher leads a discussion of the major decisions the students faced in the focal topic areas (e.g., Management, Marketing).[1]

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[1] Note that the focal topic areas are represented in about 60 percent of the qualitative (i.e., multiple choice) decisions the students face. So for instance in the first session of Module 1, students might face 3 decisions on Management issues, 1 decision that focuses on Marketing, and one decision that involves communication skills. This allows the simulation to maintain its fidelity (i.e., having different types of things happening at once) while it enables the teachers to focus their lesson plans.

5. Student-Guided Analysis and Planning

   Students work in their teams analyzing their results from the printouts, and plan for their future simulation sessions.

6. Teacher Summary and Student Activities

   The teacher summarizes the focal topic area and provides an activity for the students to apply what they have learned.

7. Non-Computer Simulation Activity

   Because neither the computer nor the simulation is an appropriate learning tool for all circumstances and learning goals, we utilize non-computer exercises that are part of the simulation fiction, but are not part of the computer-based portion of the simulation. For example, students have to write a letter to the operating partners of the hotel persuading them to authorize renovations to the restaurant. This activity takes several days and is not amenable to the computer-based simulation format. Nevertheless, the results from this activity are input into the computer-based fiction so that students will see the effects of their work in the simulated world. For example, some teams will receive better restaurant renovations than other teams, ultimately leading to increased revenues and higher profits.

8. The Repeating Cycle

   After students complete the non-computer simulation activity, they again play the simulation for two days and follow that up with three days of classroom discussions and activities.

Unique Overarching Goals for Simulations

Simulations are qualitatively different than other instructional interventions. Where other interventions focus on small, often disparate elements to be learned, simulations aim to prepare students to perform in a particular environment or at least understand some of the important relationships within a particular environment.

In the Classroom, Inc. project, the goal is to prepare high school students for entry-level jobs in the corporate world. There is a hope that students who play the simulation will become more familiar with the language that is used in the corporate environment, the structure of a typical business organization, and general business operations.

In essence, we want students to know how to react to particular situations when they enter the workplace. We want the simulation to present such situations. Moreover, we want the students to understand the general issues inherent in such situations so that they can generalize to other similar situations. We aim to accomplish this in four ways:

1. Give students experience with the language (and attitudes) of the corporate world.
2. Give students a feel for the major structural features within any business entity.
3. Give students an introduction to a large number of general contingencies that operate in the business environment.
4. Give students a feel for how these contingencies are connected to one another and provide students with an understanding for how these contingencies are related to the important goals inherent to any business entity.

These learning mechanisms are based on the simple notion that creating a simulated world will help students learn about that world. Of course, creating a simulated world is not a simple task, nor are attempts to do so universally successful. Nevertheless, a large part of the success of a simulation depends upon how well the simulated reality can convey the important features of the real-world environment.

Each of these four areas will now be described in more detail.

Giving the Students Experience with the Language of Business

Experience with language and the attitudes inherent in a particular language swarm—in this case the language used in the business world—does more than simply lower the cognitive workload of students entering the workplace. In addition, language provides clues to the contingencies of the environment, especially the social environment of the workplace. For example, lets take a look at the language of the simulated marketing manager.

> "Advertising is only worth so much. If we don't treat our customers properly, we are going to lose occupancy rate, and if our occupancy rate falls, we're going to lose revenues. We've got to implement a customer-service training program for our employees right now! Sure, it will cost money, but it will be a good investment in our future."

This monologue is full of direct learning points:

- Advertising is valuable, but not infinitely so.
- Treating customers properly is essential to business success.
- Treating customers improperly lowers occupancy rate.
- Lowering the occupancy rate lowers revenues
- Et cetera...

In addition to the learning points directly obtainable from parsing the text, there are additional, more indirect wisdoms:

- The marketing manager is concerned about customers.
- The marketing manager is concerned about the business and is willing to make a speech about it.
- Employees sometimes need training to perform at their best, and this training is likely to benefit the business.
- It is bad to lower the revenues.
- Employees in organizations have control, or at least influence, over the success of the business.
- In the business environment, logical arguments are the norm and are a valuable tool in decision-making.

Major Structural Features in the Business Environment

At the macro level, all businesses do pretty much the same things for the same reasons. Businesses are concerned with making profits. Profits are generated by bringing in more money than is spent. All businesses have customers. People or organizations will only become customers if a business has a product or service that they want or need. Because of these inherent constraints on a business, different businesses tend to develop similar structural features. To create an interface with customers, most companies have a marketing or sales function. To keep track of the money situations, most companies have developed an accounting or finance function.

One of the goals of the project is to familiarize students with typical business environments. Part of this familiarization involves giving students an understanding of the operations and functions of different organizational sub-units. For instance, students should understand what the marketing department does and why it does it.

Alternatively, these structural features can actually provide students with a reminder about some of the important goals of a business organization. For example, by highlighting the fact that the marketing department exists, students are reminded that customers are crucial to business success. In a sense, structural features provide students with redundant cues about why or how a business works. Note that due to the static nature of these structural features, their presence is not sufficient to create student learning. They must be integrated into the interplay of the cause and effect relationships of the simulated business.

To help students learn about the various functional areas in the business, we allow the students to take meetings with their senior staff. These senior managers each have responsibility for a major functional area: marketing, finance, engineering, human resources, etc. Managers talk about a particular issue from the perspective of their functional responsibility. For example, the finance manager tends to be concerned about cutting costs; the marketing manager is concerned with the customers; and the human resource manager is concerned about the employees of the firm.

Environmental Contingencies as Learning Objectives

In the Classroom, Inc. simulations, specific learning objectives focus on environmental contingencies and the causal effects of student behavior. For example, the following learning objectives are specified (among hundreds of others):

- Students will understand that successful companies understand and anticipate their consumer or client needs and develop products and services to meet those needs.
- Students will understand that managers can motivate their subordinates to be productive by treating subordinates fairly and equitably
- Students will understand that having raw materials available in inventory can lead to smoother and more efficient scheduling.
- Students will understand that good work in one job can lead to a promotion, more interesting responsibilities, and increased pay.
- In making decisions, students will gather the appropriate amount of information, recognizing that good decisions require sufficient information and that the process of gathering information requires an expenditure of time, effort, and sometime money.

Note that all of these objectives contains a direct or implied environmental contingency. In the first objective one contingency is, "If a company meets the needs of its clients, it will be successful." In the last objective one contingency is, "Gathering an appropriate amount of information will lead to good decisions."

The Network of Contingencies and Goal-Plan Hierarchies

If teaching the contingencies inherent in our learning objectives was sufficient to prepare students for the workplace, we could simply provide drill and practice instruction on the condition–action connection. For example, we could teach that meeting-the-needs-of-clients leads to increased-sales-revenues. There are several reasons that this is insufficient.

First, learning condition-action rules is boring. Students are not motivated by such sterile learning methodologies.

Second, the contingencies need to be interconnected. For example, in the hotel simulation, encouraging employees to treat customers properly leads to an overall improvement in customer service, which leads to an increase in occupancy rates, which leads to an increase in revenues, which leads to an increase in profits. Actions in the real-world have multiple and often chained effects. Our teaching should convey this fact.

Third, the contingencies are worthless if they are isolated from meaningful goals. Businesses have a complex web of interconnected goals, as do the people that work in those businesses. In a sense, goals are what drive the contingency engine. This is true because actors (whether they are people or organizational entities) only act in the service of meeting goals. To illustrate these points, our contingency involving meeting-the-needs-of-the-clients will only by activated if other higher-order goals have been activated. If students don't know why they should meet client needs, they won't even try. We can trace a series of goal–plan steps that would activate the need for the condition of our contingency (i.e., meeting client needs):

- Profits are a paramount goal
    - Profits can be increased by raising revenues
        - Revenues can be increased by getting more clients
            - Clients can be obtained by attempting to meet their needs
                - Et cetera ...

Students who have internalized the higher-order goals of a business will better understand why they should take certain lower-order actions.

Note how the subgoals are not uniquely qualified to fulfill the superordinate goals. For example, raising revenues is not the only way to get increased profits. Thus, despite the simple instantiation described above, an understanding of business functioning requires a very complex goal-plan hierarchy, certainly one that could not be taught with any efficiency. Simulations provide a vehicle for communicating this complex web of understanding by enabling students to participate in goal-directed actions and thinking.

Finally, teaching singular, isolated contingencies is also insufficient because of the *inert knowledge* problem (Whitehead, 1929). As stated before, our overarching project goal is to prepare students for the workplace. In doing this we don't want to simply fill their heads with facts. Instead, we would like them to know what to do when they are faced with a particular workplace situation. Thus, our goal as instructional designers is to strengthen connections between workplace situations and appropriate cognitive activity and behavioral actions. We want to situate the learning (Brown, Collins, & Duguid, 1989) in the workplace, or at least in a simulated workplace that provides appropriate hooks into the cognitive processing of the learner—hooks that will be activated later when students enter the real workplace.

An example may be helpful here. Certain business operations only make sense when the higher-order goals of a business are understood. For example, to a naive student, it might not make sense for a company like L.L. Bean to give a customer a new shirt when a seam ripped in the old one after two years of wear. On the other hand, if the student understands that customers provide revenues, and happy customers provide more revenues, the L.L. Bean policy makes sense.

Any simulation that recreates the real-world environment with some fidelity will help the learner understand the major cause and effect relationships (i.e., contingencies) of that environment. This, of course, is one of the prime rationales for using simulations in the first place. Nevertheless, simulation designers can insure that these contingencies are understood by learners by demonstrating the interconnections between contingencies and goals.

In the Classroom, Inc. hotel simulation, we include an income statement that highlights the revenue-minus-cost-equals-profits notion and a balance sheet that highlights the asset-vs-liability-and-equity notion. Moreover, the students learn that their decision-making in all aspects of company operations affects these financial statements.

Creating a Dramatic Fiction

We have sketched a rough outline of some of the theoretical-based rationales for our simulation design. Now we turn to a more holistically-based rationale, but one we think is equally as compelling.

From a user-interface perspective–arguably the most important perspective for instructional design–the defining characteristic of a simulation is that it creates a fiction! Not a fiction in the sense of untruth, but rather a fiction in the sense of a coherent, realistic interplay of characters and events. Thus, a simulation should create a realistic, coherent world that plays out like an interactive theatrical performance in which the user plays the role of the protagonist. The simulation should encourage users to get lost in the fiction (see Laurel, 1986).

The importance of fictionality is twofold. First, it is motivating and interesting. It encourages users to attend to the environment and experience their situation holistically (i.e., realistically). Second, the fiction provides a flow of events that is at least partially isomorphic to the world for which the students are being prepared. The goal for the designer is to insure that the user gets lost in the fiction, at least for a while. Anything that takes away from this first-personness or the seductive fidelity of this theatrical experience should be avoided.

The Classroom, Inc. Feedback Mechanisms

We have now reviewed some of the rationale we used for designing the Classroom, Inc., simulations. Based on these design imperatives, we wanted our feedback mechanisms to do the following:

1. Feedback mechanisms should support the user's intuitions about being a part of the simulation fiction.
2. Feedback mechanisms should clarify misunderstandings and strengthen previous learning, especially in regard to the environmental contingencies we want students to learn.
3. Feedback mechanisms should help the learner generalize to other similar situations.

Alessi & Trollip (1985) delineated two forms of feedback in simulations: natural and artificial. Natural feedback is representative of real-world cause and effect relationships (i.e., it is the effect), whereas artificial feedback is provided as a supplement to those realistic, simulated relationships. This distinction is useful because it describes how feedback can originate from the simulation model (i.e., the cause and effect relationships) or as augmentation to that model. However, as our experience will suggest, a second dichotomy may be more useful from a design perspective.

In keeping with our goal to keep the user's head in the simulation fiction, we found it useful to make a distinction between instructional feedback events that occur within-the-fiction and those that occur outside-the-fiction. Note that the distinction between "natural and artificial" is not the same distinction as "within and outside." Both natural and artificial feedback events can take place within and/or outside the fiction.

To illustrate this point by citing our simulations, an artificial index (e.g., hotel elegance) is made to feel a part of the fiction and a naturalistic model with implicit feedback (e.g., what-if analysis) is utilized outside of the simulation play.

To reiterate, fictionality is vital because it is motivating and provides students with enough experiential fidelity (i.e., the sense that they are part of a coherent, realistic world) to create transfer to the real world being simulated. Feedback mechanisms should be designed to maintain fictionality at the same time they augment the experiential learning process.

Utilizing the dichotomy between within-the-fiction and outside-the-fiction, we now turn to the feedback mechanisms used in the Classroom, Inc. simulations:

Within the Fiction

- Follow-up Scenarios
  (specific, realistic effects of multiple choice decisions)
- Qualitative Variables
  (indices of important business concerns)
- Financial Reports
  (cumulative financial effects result in changes on the income statement and balance sheet)
- Variable-based Scenarios
  (cumulative financial effects activate scenarios)

Outside the Fiction

- Text-based Feedback Report
  (specific feedback on multiple choice decisions)
- What-if Analysis
  (to see the financial effects of changes in numeric business decisions and qualitative variables)
- Student Discussions
  (students provide each other with additional feedback)
- Teacher-Guided Discussions
  (teachers lead discussions on simulation scenarios)

Each of these will now be discussed in more detail.

Feedback Within the Simulation Fiction

As we described above, the simulation fiction provides feedback that feels naturalistic, especially in its emphasis on demonstrating real-world contingencies. In other words, student actions have realistic effects. This naturalistic feedback is vital to simulation design. In fact, if you don't have this type of feedback, you don't really have a simulation.

Feedback within-the-fiction should feel naturalistic, but it doesn't have to have a precise real-world analog. For example, in the Classroom, Inc. hotel simulation, students are given an index that measures worker morale on a 1 to 100 scale. Worker morale is a realistic concept, but having it measured on a 100 point scale is not likely to be part of a general manager's everyday experience. Thus, having a worker morale index is artificial, but it works within a coherent fictional framework because worker morale is a concept that is meaningful to students and consistent with the real-world environment.

We must add a caveat here in regard to the fidelity of simulation feedback. Although one goal is to provide naturalistic feedback, often this feedback must be a less transparent version of the contingency in the real-world environment. For example, in a real-world situation in which a person makes a social faux pas, he might not learn the link between his actions and some delayed consequences—he may not understand why he is overlooked for promotion. In the simulation, the link has to be made more explicit. One way to accomplish this is to make the naturalistic feedback more potent or more direct. A second way to make this more apparent would be to add feedback outside the fiction.

The Classroom, Inc. simulations utilize four major forms of within-the-fiction feedback: follow-up scenarios, qualitative variables, financial statements, variable-based scenarios.

Follow-up Scenarios

Student responses to multiple-choice questions usually activate additional scenarios. For example, in the hotel simulation, if students fire their excellent food & beverage manager, they will then find themselves faced with the deteriorating performance of their restaurant. Specifically, a scenario might appear that has customers complaining about the food and the service, employees quitting, and restaurant costs rising. This type of feedback demonstrates the realistic contingencies in the workplace in a very powerful way—students who are involved in the decision-making get to see the results of their own actions.

Qualitative Variables

Using an object-oriented programming approach, a small set of variables are tracked during the simulation. These variables are chosen because they are meaningful to the industry being simulated and because they are relevant to the learning objectives. For example, in the hotel simulation customer-service, worker-morale, hotel-elegance, and occupancy-rate are used as qualitative variables. By playing the simulation, students learn that customer service is important in determining occupancy rate and occupancy rate is important in determining revenues. Moreover, because these variables are highlighted on the status report, the students come to realize that these are important goals to bear in mind as they work through their decision-making processes.

This feedback is available during the simulation in the form of the company's status report, but it is also printed out for the students later at the end of the simulated year (i.e., every two sessions). Students often view this feedback during play, without any apparent break in the fiction.

Financial Statements

As in most business simulations, students receive an income statement and balance sheet at the end of each year to help them understand the bottom-line financial effects of their decisions. This type of feedback provides breadth by acting as a summation of student responses. It also encourages students to stay focused on some of the primary goals in business; namely revenues, costs, and profits.

Variable-Based Scenarios

As described above, the qualitative variables (e.g., customer service, occupancy rate) are tracked in real time, using an object-oriented programming approach. Scenarios can be activated based on the level of these variables. For example, if worker-morale drops below 30, a scenario might be activated in which the human resource manager sends the users a report describing increased employee turnover. Employees might appear in the lounge, complaining about the miserable state of the company and the poor management. Like the financial statements, this mechanism provides feedback based on a trend of accumulated responses. Unlike the financials, this feedback is more specific to the day-to-day activities within the simulated company. This type of feedback highlights the instantiation of the qualitative variables, showing students the realistic effects of changes in these factors.

Feedback Outside of the Simulation Fiction

As we described above, the most important feedback for a simulation is that feedback which is a natural part of the simulated environment. Nevertheless, simulations should be augmented with additional feedback to increase the effectiveness and efficiency of the simulation in providing redundant clues to the users. Similarly, the simulation should provide additional feedback to help the students generalize their learnings to other contexts beyond the particular situation they were faced with in the simulation.

Like in the real-world environment, students moving through the simulation may miss or misunderstand some of the learnings they are given an opportunity to internalize. To combat this tendency, outside-the-fiction, elaborative feedback can provide additional acquisition opportunities and clarify misunderstood concepts.

The simulation should also help the students generalize appropriately. For example, suppose a simulated employee yells at a customer, and the student users appropriately fire that employee. Suppose that a similar situation occurs in the future and the students inappropriately fire the employee. The only difference in these situations is that in the second case the employee was brand new and hadn't taken the customer-service training course. The key here is that outside-the-fiction feedback could be used to help the students understand the critical issues, discriminating one situation from another based on subtle differences.

The simulation should also help the students understand the higher-order goals they can use to generate reasoned actions in future unfamiliar contexts. Feedback can include general, goal-based principles that will encourage the acquisition of non-situation-specific concepts. For example, suppose a simulated customer is quoted a room rate of $25 per night—well below the standard $85 per night. The students decide to charge the customer $85 because they feel the $25 is clearly a mistake the customer should have recognized. Of course, the customer gets angry and walks out. By including feedback that includes the general principal, "go-out-of-your-way-to-please-the-customer" and and its goal-based rationale, "because-customers-provide-revenues," the learning is likely to transfer to a situation in which a customer wants a non-perfumed soap.

The Classroom, Inc. simulations utilize four major forms of outside-the-fiction feedback: text-based feedback, what-if analysis, student discussions, teacher-guided discussions.

Text-Based Feedback to Multiple Choice Questions

Text-based feedback is provided for each multiple-choice alternative the students might choose. This feedback is available on-line after a decision is made and is printed out at the end of each simulation session. This feedback not only provides information about the correctness of the students' response in a particular situation. It also provides a general rule and a contextualized understanding of the principle involved. In other words, the feedback describes when, where, and why the response is good, bad, or mediocre. In addition, this feedback details the likely effects of the decision on the internal health of the organization (i.e., as measured by the qualitative variables) and the financial health of the organization (i.e., as described by revenues, costs, and profits).

Although this feedback is available during the playing of the simulation (i.e., during the fictional drama), students are discouraged from looking at it then because of the aggressive demand on their time and the fact that they will receive a hard copy of it later to peruse at their leisure.

What-if Analysis

The What-if Analysis provides students with a way to get feedback about their numeric business decisions (e.g., price of rooms, budget for advertising, salary for housekeepers). By trying different decisions and seeing how these decisions might affect their income statement and balance sheet, students learn about the subtle relationships involved in quantitative decision-making. For example, by trying different pricing strategies (e.g., same as competitor, higher than competitor) students will learn how their pricing effects the demand for their service (or product). The What-if Analysis also enables students to see what will happen if they raise or lower their qualitative variables. For instance, students can see what will happen to their revenues if customer service increases, or they can see what will happen to their profits if occupancy rates go up.

The What-if Analysis is available during the simulation sessions, but it is rarely accessed by students because it takes too much time to iteratively attempt different what-if analyses. Students are given a separate day to use the What-if Analysis to help them prepare for the numeric business decisions they face in the simulation.

Student Discussions

Students working in teams provide feedback to each other both during the simulation play and afterward in team meetings where they analyze their results and plan for the future. Different perspectives are considered as students are encouraged to take everyone's ideas into account. These discussions help students link their understanding of the learning points to ideas they might not have otherwise considered.

During the simulations the students argue and discuss the decisions that face them as they cooperatively play the role of the general manager. Although this is not true to the fiction in that multiple people are playing the role of one person, because students are discussing situations that are within the fiction the flow of dramatic events remains intact.

Additional student discussions occur after the simulation play when teammates analyze their various feedback reports and plan for future simulation sessions. These discussions occur after the simulation play and thus do not interfere with the flow of the dramatic fiction.

Teacher-Guided Discussions

Teachers discuss several of the major qualitative, multiple-choice decisions the students dealt with in the most recent simulation sessions. They use this opportunity to clarify points or focus student thinking toward certain learning objectives.

These discussions occur after the simulation play and thus do not interfere with the flow of the dramatic fiction.

Summary

Feedback mechanisms have not been well researched for instructional simulations. Simulation designers must rely on their experience or theoretically-driven notions in providing feedback to users. This paper discussed the rationale for the design of the Classroom, Inc. simulations and their accompanying feedback mechanisms. The notion of fictionality was offered as a way of conceptualizing and planning feedback for simulations. Specifically, it was suggested that feedback mechanisms should be designed to balance the need to maintain the user's intuition about being a part of the simulated world and the need to bolster and clarify specific learning points.

References

Alessi, S. M., & Trollip, (1985). Computer-based Instruction: Methods and Development. NY: Prentice Hall.

Belland, J., Taylor, W., Camelos, J., Dwyer, F., & Baker, P. (1985). Is the self-paced instructional program via micro-computer based instruction the most effective method of addressing individual learning differences. *Educational Communication and Technology Journal, 33* (3), 185-198.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18* (1), 32-41.

Carter, J. (1984). Instructional learner feedback: A literature review with implications for software development. *Computer Teacher, 12*(2), 53-55.

Clariana, R. B., & Smith, L. J. (1989). The effects of AUC and KCR feedback on learners of different ability. A paper presented at the Annual Meeting of the Mid-South Educational Research Association, Little Rock, AR, November. (ERIC Document Reproduction Service: ED 313 387).

Clariana, R. B., Ross, S. M., & Morrison, G. R. (1992). The effects of different feedback strategies using computer-administered multiple-choice questions as instruction. A paper presented at the Annual Meeting of the Association for Educational Communications and Technology, Washington, D. C., February.

Cohen, V. B. (1985). A reexamination of feedback in computer-based instruction: Implications for instructional design. *Educational Technology, 25* (1), 33-37, January.

Kulik, J. A., & Kulik, C. (1988). Timing of feedback and verbal learning. *Review of Educational Research, 58* (1), 79-97.

Reigeluth, C. M., & Schwartz, E. (1989). An instructional theory for the design of computer-based simulations. *IDD&E Working Paper No. 23.* Syracuse University School of Education. Syracuse, NY. (ERIC Document Reproduction Service: ED 289 470).

Sales, G. C. (1988). Designing feedback for CBI: Matching feedback to the learner and learner outcomes. *Computers in the Schools, 5* (1-2), 225-239.

Sales, G. C., & Williams, M. D. (1988). The effect of adaptive control of feedback in Computer-Based Instruction. *Journal of Research in Computing in Education, 21* (1), 97-111.

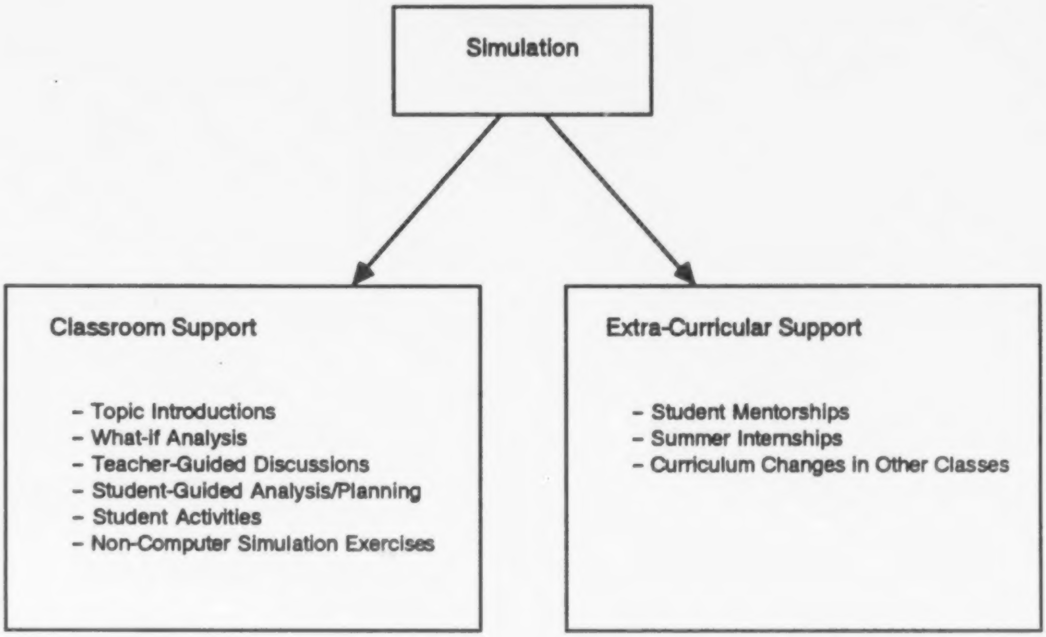
Schimmel, B. J. (1988). Patterns in students' selection of feedback in computer-based instruction. Paper presented at the Annual Meeting of the American Educational Research Association: New Orleans, LA. (ERIC Document Reproduction Service: ED 301 165).

Smith, P. L. (1988). Toward a taxonomy of feedback: content and scheduling. Paper presented at the Annual Meeting of the Association for Educational Communications and Technology, New Orleans, LA, January. (ERIC Document Reproduction Service: ED 295 665).

Sturges, P. T. (1978). Delay of informative feedback in computer assisted testing. *Journal of Educational Psychology, 70,* 378-387.

Viau, R., & Clark, R. E. (1987). Guidelines from research: Feedback during training. *Performance and Instruction, 26* (3), 6-7, April.

Whitehead, A. N. (1929). *The aims of education.* New York: MacMillan.


Simulation
Classroom Support
- Topic Introductions
- What-if Analysis
- Teacher-Guided Discussions
- Student-Guided Analysis/Planning
- Student Activities
- Non-Computer Simulation Exercises
Extra-Curricular Support
- Student Mentorships
- Summer Internships
- Curriculum Changes in Other Classes

Appendix A

Semester Schedule

1	Course Introduction	Module 3 Introduction	10
2	Module 1 Introduction	Module 3	11
3	Module 1	Module 3	12
4	Module 1	Module 3	13
5	Module 1	Module 4 Introduction	14
6	Module 2 Introduction	Module 4	15
7	Module 2	Module 4	16
8	Module 2	Module 4	17
9	Module 2	Presentations	18

Simulation Module (long)

monday	tuesday	wednesday	thursday	friday
What-if Analysis Play	Simulation Play	Simulation Play	Teacher-Guided Discussion	Student-Guided Analysis
Simulation Week 1				

monday	tuesday	wednesday	thursday	friday
Student Activities/ Teacher Summary	Non-Computer Simulation Exercise	Non-Computer Simulation Exercise	Non-Computer Simulation Exercise	Non-Computer Simulation Exercise
Simulation Week 2				

monday	tuesday	wednesday	thursday	friday
Simulation Play	Simulation Play	Teacher-Guided Discussion	Student-Guided Analysis/ Planning	Student Activities/ Teacher Summary
Simulation Week 3				

Title:

Channel One News in the Classroom: Does It Make a Difference?

Authors:

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Introduction

A recent development in secondary education in the United States has been the production and delivery of television news/information programs specifically directed towards students between the ages of 12 and 18. These shows are designed to be delivered to the students during the school day. In most cases programming is made available without cost to the schools. The Whittle Corporation with its Channel One programming has been one of the major contributors to this development. Channel One is unique in that the the television sets, video recorders and other supporting equipment are also provided at no cost to the schools. The costs of producing and delivering the ten minutes of daily news and information, the equipment located in each school, and the supporting programming and materials are covered through the sale of advertising spots embedded in the news program.

Since its beginning in 1989-1990, Channel One has been controversial in the educational community. A great deal of debate concerning the impact such a program might have on students and schools has ensued. Because it is a new approach in education, very little research data has been available upon which to base decisions. With little objective data with which to work the debates have often been marked by emotional stands on both sides of the issue. Many national organizations related to education have publicly opposed the use of Channel One in schools. Meanwhile, the Whittle Corporation and other supporters have pointed to information largely gathered by the Whittle Corporation itself, that shows the programming is effective and is well received at the local level.

Research Questions

This paper describes the results of a year long study that examined the impact of Channel One on students and teachers in a school district in Minnesota. The students and teachers were assessed on their knowledge of current events and United States geography. The results were compared to those of students in similar schools in Minnesota but which had not been receiving the Channel One programming. In addition, the study attempted to assess student and teacher reactions and attitudes toward the commercials on Channel One.

The primary objectives of the study were to:

1. Determine if a correlation exists between the reception and non-reception of Channel One programming in the schools on student's general knowledge of national and world current events.
2. Determine if a correlation exists between the reception and non-reception of Channel One programming in the schools on student's ability to correctly position United States locations on an outline map.
3. Assess the attitude of students towards Channel One commercials.

Sample

Four hundred forty-nine students in grades 6 through 12 from three Minnesota public schools receiving Channel One were selected as the experimental group. Four hundred four students in grades 6 through 12 from three Minnesota public schools not receiving Channel One were selected as the control group. Care was taken to match the schools as to size and socioeconomic base of the community. Media specialists and teachers in the respective schools selected intact classes of students for participation in the study.

In addition, fifty-two teachers from the same schools were included in the study. Twenty-seven of the teachers were from the schools in the experimental group and the remaining twenty-five teachers were from the schools in the control group. All teachers volunteered to participate in the study.

Methodology

Students and teachers in the experimental and control groups were administered identical written surveys to assess their knowledge of national and world information. Participants were asked to respond to ten multiple choice questions concerning recent events in the United States and elsewhere in the world. Questions were written based upon information available from local newspapers, newsmagazines, and radio and television news programs. Questions were written only on information or events available from at least two sources other than Channel One. The surveys were administered by the regular classroom teacher. Because of the content of the questions all surveys were administered within a three day time period.

The surveys also included an outline map of the United States and a list of four states plus Washington, D. C. Participants were instructed to mark the location of each state or city on the map.

In addition, the students and the teachers in the experimental group were assessed on their attitudes toward the commercials contained in the Channel One news show. They were asked to mark on a five point likert-like scale their level of agreement or disagreement with each statement.

Results

Students in the experimental group were able to accurately position significantly more U.S. locations than students in the control group. There was also a tendency for the students in the experimental group to answer more questions correctly on the test of general knowledge than the students in the control group, although this finding was not significant at the .05 level.

Table 1: Experimental vs. Control Students

	Experimental Mean (n=449)	Control Mean (n=404)	t Value	Probability
General Knowledge	5.3	4.8	1.95	.052
U. S. Locations	3.5	3.0	5.62	.000

As expected, there was no significant difference between the test scores for the teachers in the experimental group as compared to the teachers in the control group. Also as expected, the teachers scored significantly higher on the general knowledge questions and positioning U. S. locations than the students.

Table 2: Experimental vs. Control Teachers

	Experimental Mean (n=27)	Control Mean (n=25)	t Value	Probability
General Knowledge	7.8	7.9	.11	.914
U. S. Locations	4.6	4.8	.69	.494

Table 3: Experimental Teachers vs. Experimental Students

	Teachers Mean (n=27)	Students Mean (n=449)	t Value	Probability
General Knowledge	7.8	5.3	2.45	.014
U. S. Locations	4.6	3.5	4.02	.000

Table 4: Control Teachers vs. Control Students

	Teachers Mean (n=25)	Students Mean (n=404)	t Value	Probability
General Knowledge	7.2	4.8	5.86	.000
U. S. Locations	4.8	3.0	6.43	.000

Statements concerning student's and teacher's attitudes toward commercials on Channel are listed below followed by the percent indicating the level of agreement or disagreement with each statement.

The commercials on Channel 1 disrupted the classroom environment.

	Agree 1	2	3	4	5 Disagree
Students	10.6	8.1	19.6	17.8	43.6
Teachers	11.1	3.7	29.6	18.5	33.3

They are the kind of commercials that keep running through my mind after I've seen them.

	Agree 1	2	3	4	5 Disagree
Students	31.2	22.3	22.3	11.1	13.1
Teachers	7.4	37.0	25.9	18.5	11.1

The commercials reminded me that I'm dissatisfied with what I'm using now and I'm looking for something better.

	Agree 1	2	3	4	5 Disagree
Students	6.3	11.1	27.8	22.4	32.4
Teachers	3.7	3.7	11.1	25.9	55.6

I liked the commercials because they were personal and intimate.

	Agree 1	2	3	4	5 Disagree
Students	8.0	10.9	29.5	21.8	29.8
Teachers	11.1	18.5	29.6	7.4	33.3

I've seen these commercials so many times--I'm tired of them.

	Agree 1	2	3	4	5 Disagree
Students	31.5	19.1	27.4	9.7	12.4
Teachers	37.0	29.6	18.5	14.8	0.0

The commercials irritated me--they were annoying.

	Agree 1	2	3	4	5 Disagree
Students	13.3	9.7	23.0	23.5	30.5
Teachers	11.1	11.1	22.2	29.6	25.9

The products advertised on Channel 1 are approved by the teachers.

	Agree 1	2	3	4	5 Disagree
Students	15.7	17.1	40.8	11.8	14.7
Teachers	7.4	11.1	29.6	11.1	40.7

Conclusions

The fact that students exposed to Channel One were better able to position U. S. locations on a map than students not exposed to Channel One indicates that viewing Channel One is positively correlated with this geography skill. A possible explanation for this is the extensive use of maps and other graphics showing U. S. locations on the Channel One programs. The exposure to news and current events via Channel One could also explain the student's tendency to answer more questions correctly on current events although this finding was not significant at the .05 level as indicted above. Additional study in this area is need to fully assess the impact Channel One is having on students.

A majority of the students and of the teachers did not find the commercials disrupting to the classroom environment (61% and 52% respectively) or that the commercials were annoying (54% and 55% respectively). Although a majority of both groups indicated they were tired of the commercials (51% and 67%). These findings could be explained by amount of exposure students and teachers have to commercials in their daily life. People may be so accustomed to them they do not find them disruptive or annoying even though they do feel tired of them. In this respect, this study seems to indicate from Channel One has had very little impact on students or teachers. The finding that a much greater percentage of teachers indicated a level of "tiredness" with commercials could be explained by the fact that the commercials are directed at the age level of the students rather than adults.

A majority (54%) of students indicated the commercials were the kind that kept running through their mind tends to indicate the commercials are effective in getting the product into the student's thoughts. However, 55% of the students indicated that the commercials did not remind them they were looking for a better type of product. Fifty-one percent of the students also indicated they did not think the commercials were personal and intimate. This seems to indicate that consciously students were not looking at the commercials to change their buying habits.

When asked if they thought the products advertised on Channel One were approved by the teachers, the students gave no clear indication. The largest group (41%) was undecided on this issue with the remainder of the students being relatively evenly distributed in the other four categories. This may be one area that teachers will want to address in assisting students to become more informed consumers. Teachers may wish to indicated to students that even though a product is advertised in materials that are part of the curriculum, there does not necessarily mean the teachers have approved that product.

This study indicates that Channel One programming has had a small, but positive impact on students in a least one area of geography skills. At the same time, the commercials seem to be tolerated as a part of the packaging similar to the way commercials are viewed on commercial television. This might indicate a blurring of the lines in student's minds between formal education and other aspects of their lives.

Title:

A Survey of Student Teachers' Library Media Skills: A Replication

Author:

Glenda B. Thurman

A SURVEY OF STUDENT TEACHERS' LIBRARY MEDIA SKILLS: A REPLICATION

Literacy is defined as the ability to read and write. An extension of this definition for the information age is "the ability to locate, retrieve, select, organize, evaluate and communicate information. Cast in a slightly different fashion, . . . the ability to access, assimilate, and transfer information" (Thurman, 1987). It is assumed that the hallmark of an educated person is the ability to access information on any topic, in a field of interest or profession, assimilate the material, and communicate the resulting information. This assumption is made, not only for all students who achieve a baccalaureate, but particularly for those who propose to enter the field of teaching. It will be their task to maintain and improve the literacy of our children.

The ability to access information by student teachers is the basis for this study. For if teachers are to teach students to access information, they must possess the bibliographic/mediagraphic skills first. Although this study is addressing an issue of the information age, it emerged in the literature nearly thirty years ago.

In 1964, when school libraries were beginning the transformation into library media centers, Witt made the following observations about the proficiency of teachers' library skills:

> "No one is more influential than the teacher in shaping the curriculum and in determining the nature and extent of a learner's achievements. Consequently, if we are to have teachers who believe it important to use many different types of materials for teaching and learning and who know how to use these materials appropriately and effectively, steps must be taken to make certain that teachers develop the values, knowledges and skills essential to this sort of professional behavior." (p. 37)

During the mid-sixties a five-year collaboration between selected teacher education institutions and public schools was funded by the Knapp Foundation to provide the training described by Witt (Sullivan, 1967, pp. 13-15). A result of the project was the construction of "a 13-item questionnaire to test teachers' knowledge of the availability and use of library resources and services" (Walker, 1967, p. 17). "Eleven of the 13 items on the questionnaire were factual items. The other two asked the student teachers to name ways the library and librarians could be of service to them in their teaching" (Walker, 1967, p. 23). The questionnaire was given to 85 student teachers. The resultant data suggested two trends: 1. that student teachers use a small number of references or sources of information; and 2. they have a merger concept of how the library and the librarian can help them in their teaching (Walker, 1966, p. 66).

In the final report of the project, the editor stated that there were several implications for teacher education: 1) that unless teachers understood the library's function and utilize its resources, they could not provide information for each child on his own level of learning, and cultural background; and 2) that the teacher training institution has a responsibility to prepare teachers who understand this role of the library and who will make use of all its resources (Sullivan, 1968, p. 121).

In College and Research Library News, an American Library Association (ALA) committee issued a similar statement that "Students in education need an increasingly sophisticated knowledge of library resources in order to access information in the discipline" (1981, p. 209). The Bibliographic Competencies for Education Students Committee developed an instrument to evaluate competencies primarily in the professional instruction of teachers, e.g., reference materials accessed by teachers-in-training, rather than teachers-in-service. The focus of the thirteen item instrument was the skills needed as an undergraduate or a graduate student in education, rather than the knowledge base needed by a practicing teacher. There has been no reported use of this ALA instrument in the literature.

Six years later a tangential study in Ohio surveyed "elementary-education faculty at teacher-training institutions in Ohio . . . to explore attitudes toward the elementary school teacher's role in research skills instruction and toward library instruction in teacher-training programs . . . , [since] elementary schoolteachers play an important part in the development of both bibliographic skills and the critical-thinking skills that are necessary to complete research tasks successfully" (O'Hanlon, 1987, p. 17). The survey results supported the teaching of library skills to future teachers.

A search of Tests in Print III to locate measurement instruments for determining library media skills of student teachers yielded relatively dismal results. Three tests were located, one for grades 7 through college, one a high school through college "Test on Use of the Dictionary," and a set of three library tests for college. The information for each indicated either they were old, 1980, 1955-63, 1967-72 respectively; or the in-print status was uncertain (Mitchell, 1983, pp. 214, 425).

In addition to the scattered and negligible research reported in the literature, another force is impending which will call for the kind of research study reported here. Increasingly states are implementing curriculum guides which suggest teachers teach study, reference or research skills, in essence library media skills. As an example, The Arkansas Curriculum Guides include the following basic skills: Location of information using the card catalog, encyclopedia, an index, and a table of contents (Language Arts--Grade 6, p. 10); identification of the four types of cards in the card catalog and location of books by using call numbers (English I--Grade 9, p. 7); and the location of information in a bibliography, using footnotes, using a thesaurus, using the Reader's Guide and Who's Who" (English II--Grade 11, p. 16). To date there has been no measure of accountability included in either teacher education nor teacher practice of the skills.

Therefore, rather than develop an instrument to measure student teachers' library media skills, it seemed prudent to replicate the questionnaire used in the Knapp Foundation's Project. This was used to evaluate the skills student teachers took into the field. The results are compared with those of the original study to determine whether the findings remain stable with the passage of time, or not. Also the results are somewhat indicative of the state of student teachers' library media skills, as well as the instruction received in institutions of higher education.

Thus the primary objective of this study was to replicate the survey of the Knapp Foundation Project, edited and appended to for currency, to assay the current status of student teachers' library media skills. A secondary objective was to expand the population studied to include all teacher education institutions in the state of Arkansas, rather than 85 subjects at experimental sites within three states as was done initially. A tertiary objective was to accumulate a database of responses for subsequent studies which will include the administration of this questionnaire, in closed form, to a selected population that is geographically dispersed.

Methodology

As stated previously, the primary objective of this study was to replicate the survey of the Knapp Foundation Project, to assay the current status of student teachers' library media skills. Data for this study was collected by mailing sets of questionnaires to contact people in identified teacher education sites, administered to students just prior to their field-experience, and returned to the University of Central Arkansas for collation and analysis.

Subjects

The subjects were student teachers who began their field-experience in the spring of 1991 in Arkansas. Of the 19 institutions listed, 5 of the major schools of education participated, with 444 students responding to the survey.

Materials

The survey instrument was a 22-item, open-ended questionnaire. The items had been administered to several graduate educational media/library science research classes over a 2-year span of time to clarify the questions. However, the 13 items of the original questionnaire retained their initial intent, if not form, while other items were added for administrative purposes (3) or provision for technological changes in information acquisition (6).

Procedures

Based upon state department of education lists, each school of education dean within the state was contacted by letter to gain their support, arrange the administration of the questionnaire, and identify a contact person; included was a postcard to return the name of the contact person, the time for administration of the survey, and number of students that would be participating. According to the schedule of administration, sets of questionnaires were mailed to each contact person, with a letter of transmittal and a pre-addressed stamped envelope for return. For any packages of questionnaires which were two weeks late, according to the schedule of return deadlines, the contact persons were telephoned as a reminder.

Analysis

The responses to each question were entered and frequency counts were tallied for each institutional group. Then the resulting top 10 categories for each question from each institution were merged into a final frequency count tally. A conscious effort was made to enter open-ended responses with a minimum of interpretation, to obtain categories for the tally. From the pooled tally, the top categories for each question were ranked. All of the data was pooled, therefore no linking of respondents and responses was attempted, i.e., according to elementary education, secondary education, and fields of specialization respondents, as was done in the original Knapp Foundation study.

Results

To report the results, the questions and responses have been assembled into five content categories: Background information, Bibliographic skills, Mediagraphic skills, Bibliographic/electronic sources, and Perceptions of library and librarian.

Background

The first three questions were posed for background and administrative purposes to determine who the subjects were, what skills they had learned, and where they had learned their skills. Based on the first question, the major field of study in education, the following response pattern emerged: Elementary Education, 245; Secondary Education, 184; and Other/blank, 15.

The next question asked whether the student's college work included instructions in library skills or media skills and in what class? Of those responding, 65% (272, n = 416) reported library instruction, and 90% (368, n = 411) media instruction. Instruction was most frequently encountered in a special media class; then in order, part of another class, orientation sessions, a special library class, and other classes.

The last question dealt with student teachers' perception of whether they had learned to use the library (library media center) effectively in their teaching or not. Two hundred seven or 48% (n = 428) felt they had learned to use the library effectively in methods classes, other classes, and special library classes.

Bibliographic skills

In the next section of the questionnaire bibliographic skills were addressed. For example, one question asked "You can locate a book through the card catalog by looking up its" what? Students listed author (430), title (421), subject (378), and other (49). Indicative of the pattern of responses for library skills, was the question which stated: "If a student wanted to see if any magazine articles had been written on a topic you have given him/her to explore, what reference works would you suggest?" The top 10 responses, in rank order, were the following: 1. The Reader's Guide to Periodical Literature, 2. ERIC, 3. periodicals, 4. the card catalog, 5. microfiche, 6. an index of journals, 7. a periodical catalog, 8. a computer, 9. ask a librarian, and 10. microfilm.

Mediagraphic skills

Four questions specifically addressed media skills. First, students were asked what was "the main difference between an opaque projector and an overhead projector." Of the 326 responding, 61% (199) were correct, and 39% (127) were incorrect. Then, the question "to find out what filmstrips are available on a given topic, what reference would you consult?" was asked. The top responses, in rank order, were: 1. the card catalog, 2. ask a librarian, 3. an educational cooperative agency, 4. the state PBS affiliate, 5. a filmstrip catalog, 6. a media guide, 7. a book of filmstrip titles, 8. a library, and 9. a curriculum lab. The third question dealt with listing "constraints imposed on teachers by the 1976 copyright laws (or subsequent revisions of the law)." The responses, in rank order, were: 1. get permission to copy, 2. the number of copies that can be made are limited, 3. the law varies with the type of material copied, 4. copied materials must be used in classrooms, 5. no profit should be made with copies, 6. there is a time limit, 7. materials cannot be copied, 8. purchase--don't copy, and 9. plagerism. The fourth, and last media question was one that was added to reflect newer technology: "what source(s) would you use to find appropriate microcomputer disks to support classroom teaching?" In rank order, the top responses were: 1. catalogs, 2. software guides/catalogs, 3. the library, 4. ask the librarian, 5. ERIC, 6. "Only the Best" magazine, 7. the card catalog, and 8. books.

Bibliographic/electronic sources

Six more questions addressed bibliographic skills, two of which crossed the boundary of media, those of electronic reference sources and electronic databases. The answers to one is indicative of the other, when asked to name an electronic reference source which includes full text, or name electronic databases that serve as indexes to information, the resultant distribution was slightly different but the categories were the same. The query on electronic databases gained the following, in rank order: 1. ERIC/CD-ROM, 2. computer, 3. microfiche, 4. video, 5. microfilm, and 6. Psych. Lit.

Perception of library and librarian

The last two questions, from the original questionnaire, reflect students' perception of the library [library media center] and the librarian [library media specialist]. In response to the question: "How can the library be of service to you in your teaching?", twenty catagories emerged. The top 10 catagories, in rank order were: 1. provide/access media, 2. have research materials for students and teachers, 3. have references, 4. have books/trade books, 5. children/teachers can get books, 6. have topic/content background resources, 7. provide information, 8. have ideas [for bulletin boards, activities, etc.], 9. have media equipment, and 10. have many resources. To elicit the students' understanding of the librarian, the following question was posed: "As a classroom teacher, what competencies would you expect the school librarian to possess that would enhance and supplement your teaching?" The top replies, in rank order, were: 1. know library and use of its materials, 2. have knowledge of sources, 3. be able to access information, 4. have media experience, 5. be able to help teachers find information, 6. work with and have an interest in students, 7. know what's available, 8. have a willingness to help students, and 9. be able to access information for teachers.

Discussion

The objectives of this study were met, with varying degrees of success. The Knapp Foundation Project survey was edited and appended to for currency, and replicated. The objective to expand the population studied, had mixed results. The number of subjects was expanded to include 444, by far more than the original 85; but the expansion to the 19 teacher education institutions in the state of Arkansas, fell short with 5 participating institutions. Even though the original intent of this study was to survey the state population, the dominant teacher education institutions did participate. The third objective, to accumulate response data for subsequent studies was partially met; most of the response categories were too general to be used to create a closed-form questionnaire, but can be used to guide the construction of another survey form.

In response to bibliographic skill questions, the trend seemed to be from a limited set of specific responses students probably learned prior to college, to very generalized responses; overall students have a good general sense of information genre, without knowing a range of specific titles. This trend continued when electronic bibliographic resources were examined. Very likely the recent incorporation of computerized indexes and online database technology has contributed to the confusion of what an electronic resource is, a computer, the CD-ROM disk, or the specific program driving the information search.

Responses to mediagraphic skill questions varied greatly. The most surprising result was the response to the opaque/overhead projector distinction. The correct replies either centered on the type of materials each projector used, the lighting in the classroom when used, or the relative heat produced in operating each projector. Then when queried about filmstrips, students seemed to be aware generally of where to find information, but tended to mix media; this probably reflects the current emphasis on "high technology" in teacher education to the detriment of other media. The previous speculation on "high technology" is borne out with the results of the copyright question, since it is often related to copying computer programs and videotape when addressed in methods coursework.

The students' perception of the library and librarian seemed to be mixed, with the egocentric expectation that the library would have all the materials a teacher would ever need to teach a class; and then have a perceptive insight into the competencies a librarian should have. This dichotomy is probably due, in part, to the questions being framed in terms of library and librarian, rather than library media center and library media specialist. There may also have been confused expectations based upon students' experience in a college library, and the distant memory of earlier schooling.

In comparison with the two trends suggested by the Knapp study, today's students still seem to: 1. use a small number of references or sources of information, and 2. have a merger concept of how the library and librarian can help them in their teaching; though their concept of a "librarian" is limited, it seems perceptive.

In conclusion, this study was phase I of a three phase research project. In phase II the questionnaire will be reformatted so that subjects can check answers, it will include media items that deal with telecommunications and microcomputers, and the sample for study will be drawn from four states. In phase III the closed-form questionnaire will be conducted nationwide.

References

Arkansas Department of Education. (1985). Grades 4-6. Little Rock, AR: Author.

Arkansas Department of Education. (1985). Language Arts. Little Rock, AR: Author.

Mitchell, J. V., Jr. (1983). Tests in Print III. Lincoln, NE: The Buros Institute of Mental Measurements The University of Nebraska-Lincoln.

O'Hanlon, N. (1987). Library skills, critical thinking, and the teacher-training curriculum. College and Research Libraries, 48(1), 17-26.

Sullivan, P. (1967). Impact: The school library and the instructional program. Chicago: American Library Association.

Sullivan, P. (Ed.). (1968). Realization: The final report of the Knapp School Libraries Project. Chicago: American Library Association.

Thurman, G. B. (1987, February). Issues of the information age. Faculty lecture series: Great Human Issues, conducted at the University of Central Arkansas.

Walker, J. L. (1966). Student teachers' knowledge of library resources and services. In D. Stryker (Ed.), New Trends in English Education (pp. 61-67). Champaign, IL: National Council of Teachers of English.

Walker, J. L. (1967). What do student teachers know about libraries? School Libraries, pp. 17-23, 16(2), 17-23.

Witt, P. W. F. (1964). Teacher education and school libraries. School Libraries, 14(1) 37-46.

Bibliographic instruction: Bibliographic competencies for education students. (1981). College and Research Library News, 42(7) 209-210.

Title:

Building Microcomputer-Based Instructional Simulations: Psychological Implications and Practical Guidelines

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Abstract

Most theories of instruction specify that students should engage in meaningful interaction within an actual learning situation in order to construct their own understanding of a domain of information. When students do so, the information they glean will be salient, generalizable and less subject to forgetting. Learning from actual situations, however, is often not practical and/or is sometimes expensive (in terms of costs versus benefits) for many learning tasks. Therefore efficient learning sometimes requires the availability and use of instructional simulations and/or other interactive learning environments. Such instructional simulations are now possible and readily available, thanks to the advent of the microcomputer.

In this presentation we target four major topics from psychology that are relevant to the design of microcomputer-based instructional simulations. These four issues are: (a) cognitive structure; (b) cognitive strategies & metacognition; (c) automaticity; and (d) affect. In addition we put forth several guidelines for creating instructional simulations with these topics in mind.

Building Microcomputer-Based Instructional Simulations: Psychological Implications and Practical Guidelines

Introduction

The advent of the microcomputer has resulted in an increased interest in the design and use of instructional simulations. This type of simulation has the potential to enhance the transfer of learning by teaching complex mental and procedural tasks in an environment that approximates fairly realistic settings (Reigeluth and Schwartz, 1989). However, many microcomputer-based instructional simulations produced today are poorly designed from a psychological standpoint (Hill, 1989), and therefore do not provide an effective learning environment.

There seems to be a dearth of information concerning how to specify and implement appropriate instructional designs for this type of learning context (Alessi, 1988). This presentation represents our attempt at identifying areas in the psychological literature which have important implications for the instructional design of microcomputer based simulations. Following is a representative summary of the information we have gleaned from research in the areas of training, instruction, cognitive psychology, and human factors. In our presentation we will present these themes and concepts in a much finer level of detail.

Cognitive Structure

Our view of the world, of ourselves, of our capabilities, and of the tasks we are asked to perform, depend quite a bit on the mental conceptualizations we bring to a task. As we act and react to the environment, to others, and to the machines (including training devices) around us, we form and/or modify our internal mental representations of the things with which we are interacting. These statements hardly need to be said but we do so because they represent an underlying theme which will surface again and again as we discuss the psychology of instructional simulations.

Implications. One of the key questions a designer of instructional simulations needs to ask is; "What constitutes good strategies for making instructional simulations conducive to improving cognitive structure?" We give several suggestions below.

- Simulations should use **appropriate** imagery, audio, vocabulary and organization for the level of understanding the student is at.
- Simulations should **correspond** (at some level) to the actual systems they portray. The major elements and interactions in a simulation should conform to the major elements and interactions in the actual system.

- Present the **essential** system. The simulation should contain all the essential components, conditions, states and actions of the entity it is simulating.
- Use **appropriate detail**. The simulation should be given a level of detail that is adequate for the learner.
- Make the simulation **logical** to the user. Well designed instruction (simulation based or other) makes intuitive sense to students.
- Simulations should be inherently **meaningful** to students. That is, simulations should be based on material that explains how a system operates.

We see then, that instructional simulations are usually conducive to improving cognitive structure when they are matched with the cognitive level of the student and their instructional goals.

Cognitive and Metacognitive Strategies

Cognitive strategies are students' actions and thoughts that occur during learning and that influence motivation and encoding, including acquisition, retention, and transfer. Metacognitive strategies, on the other hand, refer to students' knowledge about and control over their cognitive processes (Wittrock, 1986). Both these terms are broad and loosely defined areas that relate to many of the issues discussed previously.

Successful students are found to use a variety of cognitively oriented strategies to: (a) pursue learning goals; (b) relate new knowledge to old; (c) monitor understanding; (d) infer unstated information; and (d) review, reorganize, and reconsider their knowledge (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989).

On the other hand (and perhaps more importantly), recent cognitive research also indicates the ways unsophisticated learners approach and think about learning. Recent literature, such as Scardamalia, et al. (1989), indicates that unsophisticated learners are prone to: (a) mentally structure information by topic rather than by goal (Schoenfield & Herman, 1982), (b) focus mainly on surface features (Chi, Feltovich & Glazer, 1981; Silver, 1979), (c) use straight ahead rather than recursive procedures (Anzi & Simon, 1979), and (d) use an additive rather than transformational approach to learning.

Implications. These findings indicate that in order for instructional simulations to support expert-like (meta) cognitive strategies, they will need to encourage students to take an active part in the learning process, rather than the passive role they are often assigned (or often assign themselves). But how can such support be provided ?

Foremost, the simulation needs to provide the kind of support that will enable learners to take maximum advantage of their own intelligence and competence. Following are some suggestions for developing the kinds of supports that are needed in simulation based training.

- Encourage strategies other than "practice." or "rehearsal."
- Support **knowledge construction** activities.

- Make concern for **cognitive goals** a very high priority. Make certain that students are aware of the cognitive goals that are to be achieved by using the simulation.
- Encourage **examination and employment** of existing knowledge.

Automaticity of Cognitive Processes

When a task can be performed such that it no longer requires the deliberate attention of the student, it is said to be automatized. A large body of scientific research points to the fact that automatic cognitive processing is a fast, parallel process, not limited by short-term memory, requiring little effort or attention by the performer, but requiring extensive and consistent practice to develop. Its use is heavily implied in various aspects of skilled behavior such as reading, playing a piano, or flying an aircraft. In contrast, controlled cognitive processing demands much attentional capacity, is serial in nature, is limited by short-term memory, and frequently requires conscious effort (Fisk, 1989).

Implications. Research shows that for many tasks, both behavioral and cognitive, automaticity develops slowly and often only after massively repetitive practice (Myers & Fisk, 1987). The single most critical factor in determining how well a skill is automatized seems to be the manner in which the task is presented to the learner. As Fisk (1989) stated;

> "Research supports the common observation that the way people typically perform a novel task (i.e., in a slow, effortful, and error-prone manner) is quite different from how they perform the task after lengthy practice (i.e., quickly, accurately, and with little effort). Such performance differences between novice and skilled individuals have led researchers to suggest that complex performance is the result of two distinct forms of information processing. In this paper we refer to these processes as automatic and controlled information processing. . . . Automatic processes can be developed only through extensive practice under consistent conditions. . . . Conversely, the use of controlled processes is implied when no consistent rules or no consistent sequences of information processing components are present in a task. (p. 453-454)

Automaticity then seems to be the result of repeated exposure to consistent stimuli over a relatively short period of time. In addition to the admonition that tasks must be consistently presented in order for automaticity to occur, several other implications can be gleaned from recent research.

- Make the **consistencies overt**. Under certain conditions, the consistent features of the simulated task may need to be pointed out to students so that they can "tune-in" to them (Fisk & Schneider, 1981).
- Make the student an **active participant** rather than passive observer. Automaticity implies active responding. The simulation should strive to make the student respond overtly to the situation (Schneider, 1985).

- The difficulty level of the simulated task should be such that students are **consistently successful** at performing it. Students may need massive amounts of "successful" practice before the skill will be automatized.
- Training should take place under **relatively stress free** conditions. A good instructional strategy is to increase the stressfulness of the simulated task only after it is well on its way to being automatized.
- **Isolate components** of tasks which one wishes to automatize. Frederiksen and White (1989) have shown that it is possible to decompose cognitive tasks and isolate their components so that automatization through training can take place.

Affect

The last issue concerns affect or the motivational appeal of the instructional simulation. At first blush, affect may seem to be fairly unimportant. However, a meta-analysis by Deckers and Donatti (1981) indicates that while simulations may not always be more effective than conventional instruction methods, they exhibit a high motivational component. Earlier studies by Taylor and Walford (1972) and Thiagariajan (1973) concur with this finding. According to Adams (1973), it is a simulations power to "unite the cognitive and affective areas" that makes it potentially useful.

Implications. Affect is a very complex construct, and as such, manifests itself in many ways. For example Dittrich's (1977) studies led him to conclude that a simulation's perceived fidelity is more motivational for learning than actual fidelity. He suggested that either very low or very high fidelity simulations will be perceived as low while medium fidelity simulations will be perceived as high and hence will enhance positive motivation on the part of students. Other research shows that when the (poor) attitude of students requires highly motivational instruction, simulations incorporating principles of gaming should be created (Malone, 1981; Priestley, 1984; Reigeluth and Schwartz). Research by Malone (1981) indicates that three factors, challenge, fantasy, and curiosity contribute to creating a positive affect on the part of learners. The specific guidelines that follow provide a brief summary of some of the relevant literature.

- Provide clear **goals** for students to attain.
- Provide **uncertain outcomes**. If learners are absolutely certain to reach the goal or certain not to reach it, the simulation is probably not challenging enough to sustain their interest.
- Use a **non-zero based scoring** system.
- Create **competitive** situations.
- Stimulate, satisfy, and sustain student **curiosity**.

Summary of Issues and Implications

Table 1 summarizes the issues and their implications for the design and use of instructional simulations. Many of these implications are not mutually exclusive, but typically perform interactively during an instructional simulation. They are set apart here to emphasize the underpinnings of the cognitive approach.

While these issues are probably not new or unfamiliar to training professionals, it is our observation that they are not being considered to the degree that they could be in the design of simulation programs used for training and instruction. We believe that instructional simulations should be designed, used, and evaluated with these implications in mind.

Table 1. Some Issues and Implications for Instructional Simulations

Issues	Implications
Cognitive Structure	Make simulations appropriate for the level students are at
	Make simulations correspond to actual systems
	Present only the essential system
	Use appropriate detail
	Make the simulation logical to the student
	Make simulations inherently meaningful to students
Cognitive Strategies and Metacognition	Encourage strategies other than "practice" or "rehearsal"
	Support knowledge construction activities
	Make concern for cognitive goals a high priority
	Promote examination and employment of existing knowledge
Automaticity of Cognitive Processes	Make consistencies overt
	Encourage active participation rather than passive
	Structure difficulty to so as to ensure consistent success
	Strive for relatively stress free conditions
	Isolate automatic components
Affect	Provide clear goals
	Provide uncertain outcomes
	Use a non-zero based scoring system
	Provide a competitive situation
	Stimulate, satisfy, and sustain curiosity

References

Adams, D. (1973). Simulation and gaming: An approach to learning. Worthington, OH: Charles Jones.

Alessi, S. M. (1988). Fidelity in the design of instructional simulations, Journal of Computer–Based Instruction 15(2), 40–47.

Anzi, Y., and Simon, H. A. (1979). The theory of learning by doing. Psychological Review, 86, 124-140.

Chi, M., T. H., Feltovich P., & Glazer, R. (1981). Categorization and representation of physics problems by experts and novices. Cognitive Science, 5, 121-152.

Deckers, J., & Donatti, S. (1981). The interpretation of research studies on the use of simulation as an instructional strategy. Journal of Education Research, 74(6).

Dittrich, J. E. (1977). Realism in business games: A three–game comparison. Simulation and Games, 8(2), 201–210.

Fisk, A. D. (1989). Training consistent components of tasks: Developing and instructional system based on automatic/controlled processing principles. Human Factors, 31, 453-463.

Fisk, A. D., & Schneider, W. (1981). Control and automatic processing during tasks requiring sustained attention: A new approach to vigilance. Human Factors, 23, 737-750.

Frederiksen, J. R., & White, B. Y. (1989). An approach to training based upon principled task decomposition. Acta Psychologica, 71, 89-146.

Hill, J. V. (1989). The design and procurement of training simulators. Educational Technology, 29, 26-27.

Malone, T. W. (1981) Toward a theory of intrinsically motivating instruction. Cognitive Science, 4, 333–369.

Myers, G. L., & Fisk, A. D. (1987). Application of automatic and controlled processing theory to industrial training: The value of consistent component training. Human Factors, 29, 255-268.

Priestley, M. (1984). Computer simulations, from the dungeons to the classroom. Publishers Weekly, October 26, 64–65.

Reigeluth, C. M., & Schwartz, E. (1989). An instructional theory for the design of computer–based simulations. Journal of Computer Based Instruction, 16(1), 1–10.

Scardamalia, M., Bereiter, C., McLean, R. S., Swallow, J., & Woodruff, E. (1989). Computer supported intentional learning environments. Journal of Educational Computing Research, 4, 51-68.

Schneider, W. (1985) Training high performance skills: Fallacies and guidelines. Human Factors, 27, 285–300.

Schoenfield, A. H. & Herman, D. J. (1982). Problem perception and knowledge structure in expert and novice mathematical problem solvers. Journal of Experimental Psychology: Learning, Memory, and Cognition, 8, 484-494.

Silver, E. (Ed). (1979). Students perceptions of relatedness among mathematical verbal problems. Journal of Research in Mathematics Education, 10, 195-210.

Taylor, J., & Walford, R. (1972). Simulation in the classroom. London: Penguin.

Thiagariajan, S. (1973). Realities of Simulation/Gaming. Viewpoints, 49.

Wittrock, M. C. (1986). Students' thought processes. In M. C. Wittrock (Ed.), Handbook of research on teaching, third edition. New York: Macmillan.

Title:

Learning Environments: The Technology-Cognition Connection

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LEARNING ENVIRONMENTS:
THE TECHNOLOGY-COGNITION CONNECTION

Eldon J. Ullmer

Introduction: Perceptions of the Learning Environment

This session's common theme is that including an "environment analysis" in the instructional development process will improve learning system design. My task is to discuss the technology aspects of such an analysis; however, what this analysis should include is far from obvious. Clearly there are several possible views regarding the environment's role in learning: One, that it is neutral; two, that it is a relevant but ancillary factor; and three, that the environment is an active element in the learning process. Adopting the first attitude allows the instructional designer to ignore the environment. Adopting the second mainly means documenting those aspects of the environment that might adversely affect use of an instructional product in a given setting. Adopting the third view means recognizing the environment as part of the technology-strategy-activity nexus that all teaching involves.

I expect that some might hold that the environment is neutral with respect to learning; after all, some have argued that media do not influence learning, that they are mere information carriers. Kozma (1991, p. 205) argued that this conclusion was faulty because it did not take into account the "cognitively relevant characteristics" of media. Time does not permit discussion of this issue here; the important point is that just as a medium is more than a neutral vehicle, a learning environment is more than a neutral setting or locale.

But accepting that principle still leaves another question: Is the environment simply an ancillary factor in instructional design, or might an environment, like a medium, possess "cognitively relevant characteristics" that are, therefore, integral design factors? The way this question is answered obviously affects the ID process; therefore this inquiry focuses on two primary questions: 1) What is the case for the premise that technological learning environments are "active agents" in the learning process?, and 2) What are the design implications of accepting this premise?

Aspects of A Technology-Based Learning Environment

An advertisement for an imaging system being marketed by a major computer firm proclaimed that it was "not just a collection of graphics tools but a total working visualization environment." Tay Vaughn (1988) defined the idea of a computer "environment," saying that the term refers to "a set of rules, conditions and capabilities within which programs can be created and then run." The twin-points here are 1), a technological environment is more than an array of tools, it is a working, function-related, integrated system; and 2), that while a such a system may afford users superb capabilities, it also sets creative limits and imposes its particular rules and regimens on the user.

Kosma (1991), in his review of media research, distinguished between the learner's internal and external environments, and presented an image of the learner using his or her internal cognitive resources to manage the extraction of information from the external environment to built new knowledge. This presents a markedly different view of the learning process from the one on which the "media-are-mere-vehicles" conclusion was based. Also, it reminds instructional developers that anything that affects information acquisition and use is an active element of the learner's "external environment."

John Sculley (1991) provided an interesting perspective on learning environments while addressing the problem that although modern technology has greatly improved information processing capabilities, white collar productivity has not similarly improved, either in schools or in the workplace. Sculley said this was because "new technology has been mapped on top of an old work model and an old learning model." In the broadest sense, then, an instructional environment is what results from mapping a technology model on top of a learning model. Every learning environment thus embodies what Martin Tessmer calls a "technology culture" comprised of the available technology, the attitudes and expertise of the learners and teachers who will use it, and their perceptions of how it ought to be used to facilitate learning. Thus it is reasonable to conclude that learning environments do possess "cognitively relevant characteristics" that must be addressed during design.

The environment and learning question, then, breaks down into three related questions: What is the "new" technology model? What is the "new" education model that technology is supposed to implement? And, how should they be connected? Examining the old models will facilitate understanding the new models.

The "Old" Technology Model

A technology model embodies two complementary ideas--an image of tool-use that links device and user in purposeful activity, and an image of some functional goal that puts the "purpose" in that activity. For centuries, the printed page has been the basic tool for managing information, and Sculley says that even through the 1980s it remained as the "computing metaphor for documents." Early in this century, Thorndike provided a "big idea" about using the print medium as an instructional technology when he wished for a device that would not allow the student to go to page two until he mastered what was on page one. No one did much with that idea for a long time, but this image of tool-use remained until it emerged in the 1960s as the essential idea underpinning programmed instruction.
Although programmed instruction as a media form did not last, the basic notions that came out of that tradition remain at the center of today's dominant instructional paradigm. I call it the tools and tasks paradigm because it invokes a particular image of media use and teaching: The basic learning environment is the classroom; the teacher controls the use of technology; the learner is subordinate to the teacher; media are regarded as simple delivery tools; the objective is assimilation; and the value that drives evaluation is efficiency.

The "Old" Learning Model

Sometime after Thorndike offered his suggestion for a model teaching tool, another big idea, attributed to Frederick Taylor, took hold. This was the mass production-based "factory model" which, Sculley (1991) says, separated planning from doing and reduced the worker's role, thus minimizing the knowledge and skill required. Education's didactic form reflected this model, and didactic instruction, though widely criticized, remains the dominant form of teaching. Its deficits have been cataloged by Brown, Collins and Duguid (1989), among others: Knowledge is viewed as a quantity of abstract, self-contained facts and concepts to be "delivered" to the learner. The context of learning is thought to be "merely ancillary" to the learning process and no serious thought is given to how the learning situation might affect cognition or to how to make learning activities "authentic." Thus knowledge is separated from its environment-of-origin and no link between learning and use is formed. Consequently, success in the school setting does not ensure success in an application setting where problems are not always well-defined, nor solutions always clear-cut.

The "New" Technology Model

Over a decade ago Manfred Kochen (1981) saw the convergence of computers and communications as a new technology in the making (p. 148). Since then, powerful personal computers have become ubiquitous, optical disc systems, fiber optics and networking technology have all advanced enormously. Computer-controlled, optical disc systems epitomize the new technology. Such systems easily surpass older media in technical capabilities and also hold much potential for changing the learning process. This potential will be lost, however, if the technology is used with a deficient learning model.

The "New" Learning Model

While there is no definitive "new" learning model, several presently emerging themes illustrate a new line of thinking about instruction. One of these themes, as explained by Brown, Collins and Duguid (1989), is called "situated cognition." This idea challenges the notion that the environment or situation in which learning occurs is "neutral" or "ancillary" and argues that knowledge is a product of context, activity and culture (p. 42), that learning and cognition "are fundamentally situated." They see conceptual knowledge not as an abstract entity but as a tool, and argue that just as one acquires skill in using a tool through engagement in "authentic activities" in real-world situations, conceptual knowledge should be developed through student work that reflects what practitioners in the domain actually do.

A major design idea of the situated cognition perspective is that problem solving tasks should be staged so that a solution is reached not just by rote processing but by means that enable the learner to use the environment to solve the problem, means that are said to be "in conjunction with the environment" (Brown, Collins and Duguid, 1989, p. 35).

A related idea called "anchored instruction" is under study by The Cognition and Technology Group at Vanderbilt (1991). This group is doing research on "the effects of situating instruction in videodisc-based, problem solving environments" (p. 2) which are intended to permit students to engage in "sustained exploration" of a problem from "multiple perspectives" (p. 3).

In another context, Rappaport and Halevi (1991, p. 69) offer an interesting thesis about the computer industry when they predict that by the year 2000, "the most successful computer companies will be those that buy computers rather than build them." As a current example, they cite Microsoft, a company that does not manufacture computers, but, as the leading developer of microcomputer software, has become more successful than anyone who does. What does that have to do with instructional development? The essential idea is that the software that Microsoft makes does more than merely allow computers to run, it defines the "desktop computing environment" (p. 72), and the nature and value of computing. Likewise, good instructional design does more than merely use computers and media well, it defines the learning environment's value and utility. Sculley (1991), speaking about productivity generally, says: "The real challenge for developers will be to create products based on emerging technologies that reflect the changing way that people work in an information economy (p. 9). Instructional developers, I believe, could adopt this challenge without changing a word.

Forging the Technology-Cognition Connection

As the problem of finding powerful technology to apply to instructional problems becomes secondary to learning how to use that technology to achieve the larger goals of reorganizing work and learning, successful instructional development will require added emphasis on the design of learning environments that take into account: One, principles of "human factors," especially human-computer interaction; two, learner involvement strategies; three, the "situated nature" of learning, and four, the problem of providing "authentic" learning situations.

Human Factors

Human factors considerations relate to environment analysis at several levels. Ergonomics deals with the physical aspects of using technical devices. But human factors also must address those human capabilities and limitations that affect cognition and learning (Staggers, 1991, p. 47).

Some very useful ideas on the application of human factors to instructional development are to be found in a recent paper by Orey and Jih (1991). They contend that the nature of interaction between computers and human users is a "neglected area" of study, and they list several techniques now being explored to facilitate employing human factors in instructional design. These include adaptive interfaces, task analysis, measuring user's mental models, design audits, mock-ups, prototyping, and field trials.
All are intended to make human-computer interaction effective and "user-friendly," based on the awareness that in any setting, student populations will include people who possess vastly different skill in using computers.

Perhaps the most interesting element in their paper is a chart that relates human factors guidelines to each of Gagne's nine events of instruction, a widely-used construct in instructional development.

There is one research study with human factors elements that I find very interesting. An English professor at the University of Delaware, Marcia Peoples Halio, did a five-year study in which she compared the quality of student papers produced on Macintosh and MS-DOS machines. As reported in the Washington Post by T. R. Reid (1991), she found that DOS users produced papers with much higher readability scales and with far fewer spelling errors. Moreover, she also noted that DOS users were more likely to write about serious issues, such as war and pollution, while MAC users wrote about such topics as fast food.

The big question, of course, is, what does this mean? Reid's conclusion was simple: "Mac people" are different from "DOS people." IBM people, he says are "no-nonsense" types who follow established ways of doing things while Mac people are "free spirits" and "artistic types" who worry less about rules of grammar and spelling. Thus if "Mac people" are seen as a more creative lot and "DOS people" as a more serious group, it is interesting to speculate what will happen as the Mac becomes more like an IBM-PC and DOS-PCs adopt Macintosh-like user interfaces.

Learner Involvement

Implicit in any learning environment design is a particular "image of the learner" (Ullmer, 1989) that defines how the learner is expected to use that environment. One such "image" is what Alan Kay (1991, p. 138) calls the "fluidic theory of education" which holds that students are "empty vessels" to which knowledge is to be transferred "drop-by-drop." The notion that media are mere delivery vehicles draws heavily on this image. Not surprisingly, Kosma's (1991, p. 179) analysis of media research is based on an entirely different image--that of a learner "actively collaborating" with the environment "to construct knowledge," and strategically managing his or her "cognitive resources" to create new knowledge.

James Dezell (1988, p. 10) of IBM says that technology-based learning environments should be "responsive to the ways today's children receive information" and that these environments should be "programmed for discovery rather than instruction."

Kay (1991, p. 138) picks up on the same theme but carries it a bit further. He believes that powerful, networked computers can greatly enhance learning, "but only in an educational environment that encourages students to question facts and seek challenges," to not accept everything at face value. He agrees with Jerome Bruner that people can devise for themselves new ways of thinking and thus expand their understandings.

Situated Learning

The main idea behind situated learning, to repeat, is that environments structure cognition, that situation, activity and culture co-produce knowledge.

Kosma (1991, p. 180) holds that the learning process is "sensitive to characteristics of the external environment such as the availability of specific information at a given moment, the duration of that availability, the way the information is structured, and the ease with which it can be searched." Thus these become important design consideration with regard to mediating instruction in any learning environment.

Brown, Collins and Duguid (1989) provide a very interesting example, drawn from Lave's work, of how a situation can help structure cognition. The example is from a Weight Watchers class and the problem was how to create a cottage cheese serving that equalled three-fourths of the two-thirds cup that the program allowed. They relate how the problem solver paused to size-up the situation, then suddenly proceeded to fill a measuring cup two-thirds full, dumped it onto a cutting board, patted it into a circle, marked a cross on it, removed one quadrant, and served the rest. This is problem solving carried out "in conjunction with the environment."

Authentic Situations

Alan Kay (1991, p. 138) relates an observation by physicist Murray Gell-Mann that compares modern education to being taken to a fine restaurant and being fed the menu. He meant that students are taught in a superficial manner in which representations of ideas replace the ideas themselves. Technology will soon provide students with computerized access to massive data resources. The critical design question, Kay says, is how to get from the menu to the food. Put another way, how can designers create the authentic environments that enable students to acquire meaningful, usable knowledge?

The example of the Weight Watchers class illustrates the value of providing an authentic situation in which problem solving is carried out in conjunction with the environment. But obviously teachers cannot issue cottage cheese and other needed items to everyone studying fractions. Nor can medical students be given open use of laboratories and expensive diagnostic equipment and be issued a patient with a designated illness. This is where technology is most useful--in providing realistic simulations of the types of problems that practitioners actually encounter. But designers have to be able to recognize the key elements of the environment to be simulated.

One excellent example of such a simulation is the National Board of Medical Examiners Computer Based Testing or CBX program. The program includes several case simulations in each of several medical areas. A case might begin with a patient in an emergency room. The student user takes a patient history and does a physical exam of varying completeness depending on the urgency of the problem. The user then prescribes appropriate therapeutic measures. The program is realistic in that the user, to obtain the results of tests ordered, must advance the "clock," and, as the clock advances, the disease also progresses. As laboratory results are returned, the user adjusts the treatment regimen as deemed appropriate. Once the course of the patient has been established and the simulation ends, the user receives a list of procedures ordered correctly, those ordered unnecessarily, and decisions made that were harmful to the patient (Wilkes, 1990).

Numerous other simulations that employ similar principles are presently being used in health sciences education and educators are gaining experience in their design, and in discovering the basic requirements of good design.

Dertouzos (1991) provides an interesting way of looking at specifying design requirements for information technologies. To escape "the present chaos" regarding computer-based networks, and to fashion them into "a true information infrastructure," he says networks must have three key capabilities: flexible information transport capabilities, common services and common communications conventions" (p. 65). Because computer network users have varying needs regarding transmission speed, reliability and security, and because it is expensive to maximize all three, Dertouzos suggests, metaphorically, that it would be ideal if users could set "levers" to receive the desired level of each capability as needed. Now speed, security and reliability are important in instructional systems, too, but other design factors may be more important in creating authentic learning environments.

The question is: What are they? What "levers" does a designer need to set to maximize the effectiveness of an instructional program?

Two levers are relevant to specifying the nature of the problem: one to make the simple-to-complex setting, and one to make the fixed-solution to open-solution setting.

Two levers also are needed to set situation authenticity. Clyman (1991) outlined several assumptions that underpin the design of the CBX system discussed earlier. One is that the system will provide the degree of realism needed to elicit the behavior of interest from the student, and the second is that the system will "capture those behaviors" in a form that reasonably represents those behaviors. So one lever varies the degree of realism the problem presentation provides, the second addresses the problem of capturing what the student really wants to do.

Kay (1991) offered an interesting insight on what he considers "a well-conceived environment for learning." It should "be contentious, even disturbing," it should "seek contrasts rather than absolutes, aim for quality over quantity, and acknowledge the need for will and effort" (p. 140). This identifies two additional levers: one to set the degree of contentiousness, and the second to adjust the balance between knowledge quality and quantity.

An observation about the new software form called "groupware" provided another example in which a personality trait was attributed to a computer system. Because some users resented the high degree of control, a software program was redesigned to be "less strident." This suggests another lever to adjust the stridency level of a teaching program.

Any simulation design will likely involve these basic assumptions and problems. Instructional developers are taught well to follow rational design models. But building an ideal learning environment arguably requires something more--in applying human factors, and in setting the "levers" of design.

References

Brown, J., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18(1), 32-42.

Clyman, S. (1991, November). Continued research on computer-based testing. Paper presented at the annual Symposium on Computer Applications in Medical Care, Washington, D.C.

Dertouzos, M. (1991, September). Communications, computers and networks. Scientific American, pp.62-69.

Dezell, J. (1988). A new age in education. T.H.E. Journal (IBM PCs and Compatibles Special Issue.

Kay, A. (1991, September) Computers, networks and education. Scientific American, pp. 138-148.

Kochen, M. (1981). Technology and communication in the future. Journal of the American Society for Information Science, 32, 148-157.

Kosma, R. (1991). Learning with media. Review of Educational Research, 61, 179-211.

Orey, M., & Jih, J. (1991, November). The application of human factors to the ID processes for computer-based programs. Paper presented at the annual meeting of the Association for the Development of Computer-Based Instructional Systems, St. Louis, MO.

Rappaport, A., & Halevi, S. (1991, July-August). The computerless computer company. Harvard Business Review, pp. 69-80.

Reid, T.R. (1991). In college, Mac doesn't always make the grade. The Washington Post (edition unknown).

Sculley, J. (1991, Spring). A road map for the 1990's. Macintosh Development Services Directory.

The Cognition and Technology Group at Vanderbilt. (1990). Anchored instruction and its relationship to situated cognition. Educational Researcher, 19(6), 2-9.

Staggers, N. (1991). Human factors: The missing element in computer technology. Computers in Nursing, 9(2), 47-49.

Ullmer, E. (1989). High-tech instructional development: It's the thought that counts. Educational Technology Research and Development, 37, 95-101.

Vaughn, T. (1988). Using hypercard. Carmel, IN: Que Corporation.

Wilkes, A. (1990, September). Review: Computer based testing--the CBX cases. Medibytes, p. 6.

Title:

Preferred Length of Video Segments in Interactive Video Programs

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PREFERRED LENGTH OF VIDEO SEGMENTS IN INTERACTIVE VIDEO PROGRAMS.

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Introduction

Interactive video may be conceived as the combination of the interactive capabilities of the computer and the audiovisual power of video. This combination is generally considered as a powerful medium for delivering instruction, nowadays often incorporated in so-called multi-media systems. This article focuses on one design issue with respect to the video component.

The Problem

An essential property of adding computer control to video programs is the possibility to stop for questions or excercises, or to give feedback to students about their progress, at any desired moment. A simple but fundamental question is: What is the optimum moment to stop for the purpose of achieving maximum learning? The literature shows some ideas with respect to this question (see for instance Bork, 1987; Laurillard, 1987; Phillips, Hannafin & Tripp, 1988; Schaffer and Hannafin, 1986). One question is whether preferred segment length plays a role in this. This paper attempts to clarify this issue in the context of a larger study about optimal segment length (Verhagen, in preparation). To make the research manageable, choices were made that narrow the problem of that study down to the following central question:

> " What is the optimum length of well designed audiovisual segments to present factual information via an interactive video program to learners who possess certain characteristics?"

The exact meaning of this question is specified as follows:
- The measure for "length of segment" is the number of information elements in one segment. The term "information element" is defined as the smallest meaningful unit of language to state a name, a label or a single proposition, according to Gagné's definition of verbal information (Gagné, 1985).
- "Well designed" is operationalized in terms of the approval of the audiovisual material by an expert jury, in combination with successful formative testing of the material under development.

- "Factual information" means verbalizable information about facts, concepts, procedures and principles to be stored in memory on the recall level (see also Gagné, 1985; or Merrill, 1983; Romizowski, 1986; Wager & Gagné, 1988).
- The learner characteristics involved concern verbal ability; the ability to process pictorial information; a cognitive style aspect (field dependance); and sex. These are briefly described below.

One term cannot yet be defined, and that is what to understand by "optimum" length of a segment. It is part of the study to find out what has to be regarded as optimum. In this paper, one aspect is elaborated: the extent to which learner preference influences the way in which optimum segment length has to be regarded.

With respect to recall, two situations have to be taken into account:

a. Segment length and direct recall of information
   In general, video segments serve to initially supply learners with information as a part of a learning experience that may further consist of rehearsal or application of that information, with or without the demand to demonstrate the ability to recall the presented information by answering questions. The ability of learners to recall the presented information directly after the completion of a video segment can be considered as a measure of the effectiveness of the initial presentation. The better this is the case, the quicker a learner may proceed in an instructional situation and the shorter the needed time on task will be and thus the more efficient the learning will take place, at least as far as concerns this factor. This efficiency may be dependent on segment length.
b. Segment length and delayed recall of information
   After a learner has worked through all segments of a program, the effectiveness of the learning session as a whole may be measured from his or her ability to answer questions about the program after some time has elapsed. This effectiveness may also appear to be dependent on segment length.

The relation between segment length and direct recall may or may not tally with the relation between segment length and delayed recall. On one hand, correct direct recall may be a proof of successful information transfer, which may be confirmed by a high level of delayed recall. On the other hand; in a learning situation, mistakes with respect to direct recall will in most cases be remediated by rehearsing the missed information in one form or another. Rehearsal supports retention. Incorrect direct recall may thus cause rehearsal which leads to better delayed recall than correct direct recall, be it at the expense of increased time on task. However, there is reason to strive for maximum correct direct recall: rehearsal as a consequence of the frustrating experience of failing to answer questions correctly violates rules for motivational instruction. Keller for instance argues that instruction should be such that learners can develop confidence in their possibilities to fulfill assigned learning tasks successfully (see Keller, 1983; Keller & Kop, 1987; Keller & Suzuki, 1988). Rehearsal should therefore not be the consequence of failure by the learner, but should be carefully planned and integrated in the learning situation as an activity that appears logical to the student and may thus be easily accepted. It is possible that preferred segment length automatically provides the answer to this problem, if learners are in the position to make themselves the trade-off between segment length and failure to answer questions about the presented information. The experiment that is decribed below is designed to study this possibility.

Before turning to a description of the experiment it has to be emphasized that the study has a non-instructional character. The study is primarily designed to find rules about segment length for the purpose of the initial presentation of information as a component of one instructional pattern or another. The role of such presentations within instructional patterns is in principle not considered. It was however attempted to support the validity of the segments used in the experiments as potential building blocks in instruction by using a pattern of presentation, questioning, remediation, and feedback that resembles tutorial instruction.

Self-chosen segment length is one possibility, program-controlled segment length another. The desirability of self-chosen segment length has to be valued against its effectiveness for learning compared to program-determined fixed segment length.

A further point is whether segment length can be independent of time on task in the sense that long learning sessions may cause fatique effects that affect optimal segment length (after some time students may probably need shorter segments than when they are fresh).

With the former, the following research questions are listed:

1. What is the preferred segment length if learners have to decide for themselves how much information (how many information elements) they want to have presented to them before they stop to answer questions about that information?

2. Which is the relationship between segment length and direct recall of factual information presented by these segments
   a. when segment length is self-chosen?
   b. when segment length is fixed?

3. Which is the relationship between segment length and delayed recall of factual information presented by these segments
   a. when segment length is self-chosen?
   b. when segment length is fixed?

4. Does fatigue effect affect self-chosen segment length?

Research Method

In the study, subjects attended two experimental sessions. During the first, they mainly worked with an experimental videodisc program, followed by a posttest. This session took one morning or one afternoon. The second session was used for a retention test and for tests to score some variables with respect to individual characteristics. The second session took about two hours.

The experimental video program.

For the study, an experimental videodisc program about cheesemaking has been produced. This program contains 252 information elements that are presented through video with off-screen narration. Together they form a connected discourse of 36 minutes if the program is played linearly without stopping. According to the earlier definition, an information element is operationalized as one uninterrupted statement of the narrator about which one factual question can be put. This means that in the experiments with one question per information element in principle 252 questions could be asked about the content of the program. However, in eight cases this would have been too artificial because of the simplicity of the text concerned. In practice 244 questions were put to the subjects. The 252 information elements are distributed over 150 camera positions (shots).

The computer program is used to control the system so that the video program can be broken down into various sequences of segments. Thereby the video can only be started or stopped between two information elements. This causes video segments of the program always to consist of whole numbers of information elements. The way in which the program is broken down into segments depends on the different experimental conditions that are described below .

The video program has two parts: (a) an introduction of 4.5 minutes (information elements 1-33; 31 questions), and (b) a main program of 31.5 minutes (information elements 34-252; 219 elements with 213 accompanying questions).

In all conditions, the introduction was used twice. The first time the introduction was presented as an ordinary linear video program to give an overview of the cheesemaking process. This prepares the subjects for the presentation style and the kind of information in the main program (in which the cheesemaking process is treated in much more detail).

The second time the introduction was used to give the subjects the opportunity to experience the way of working with the main program according to the experimental condition in which he or she was placed.

It is believed that by this approach the subjects were well-prepared to enter the main program (all data about working with the program were collected during work with the main program).

Experimental conditions

Five experimental conditions were used:

VAR:
In the so-called variable condition, the subjects determined the length of each segment. The basic procedure was as follows:

- In the ready position to begin a new segment, the screen showed a video still with the superimposed message "click the mouse". This video still was the first frame of the information element with which the segment would start.
- After clicking, the program started playing until the subject decided that it was time to ask for it to stop by again clicking a mouse button. The program then stopped at the end of the information element in which the stop was requested. This defines a segment: if the playing started with element i, and the program stopped at the end of element i+k, a segment containing k+1 information elements was created.

- The subject then answered all k+1 questions about the segment he/she just saw, one question after the other. All questions were open questions that required short sentences, single words, or numbers to be typed in as answers.
- Next, all questions were one by one repeated corresponding to the order of the information elements in the segment together with the answers of the subjects and feedback about right or wrong. Right answers were reinforced by a complete sentence that restated the correct answer. If a question was encountered that was answered wrongly, the feedback informed the subject of this fact followed by the message "click the mouse to repeat the related video fragment". After clicking, this video fragment was repeated followed by a second attempt to answer the question. Also after this second time feedback about right or wrong was provided, this time together with the right answer regardless of whether the second answer was right or wrong.
- After all questions of the segment were reviewed, the subject was allowed to continue the program beginning with element i+k+1, the information element that followed the last element of the just-completed segment[1].

In this way, the subject divided the video program into segments by the repetition of watching, stopping, answering questions, getting feedback (with built-in repetition of video parts with respect to missed questions), and starting the next segment.

The VAR condition is the main condition used to answer the research questions about preferred segment length (Research Questions 1, 2a and 3a).

CROSSED:
The same as VAR, with the difference that first, the second half of the main program was presented (information elements 145-252), and then the first half (information elements 34-144). This was possible because the subjects entered the main program after the introduction (with the overview of the cheesemaking process) had been studied twice. With that background it was not an unnatural experience to start in the middle of the main program.
This condition was used to find out whether fatique effects would affect the results (Research Question 4).

LIN:
In this condition no stopping was allowed. The subjects watched the complete main program without stopping and then had to answer the 213 questions of the main program as if they had divided the program into just one long segment. This condition was made to compare linear use of the video program with interactive use. It was meant as a control condition relative to information overload if the experimental program was not segmented.

SHORT-LONG (SL):
In this condition, segment length was fixed. The first half of the program was worked through in 23 steps (short segments), the second half in 5 steps (long segments). Except for fixed length, this condition functioned in the same way as

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[1] At this place -- where a segment just has been completed -- subjects could also have a break and leave their chairs to relax in an adjacent room. To do so they were required to click the right-hand mouse button, which caused the message "pause" to be displayed and by which the logging of time was switched to the logging of the duration of the interval. To continue after a pause, subjects had to hit <ENTER> after which the video still of the first element of the next segment was displayed together with the message "click the mouse" as described above.

the VAR condition. The SL condition was used to show how recall of facts was affected by fixing the segment length (Research Questions 2b and 3b).

LONG-SHORT (LS):
The same as the former, with the difference that in this case the long segments came first. This condition was made to balance the former.

Subjects

Subjects were 235 university freshmen of several technical and social science departments at a single university in the Netherlands. Age, sex, university department, and year of study were registered. The subjects were randomly distributed over the experimental conditions with the restriction that in the first phase of the experiment, only the conditions LIN, VAR and CROSSED existed. Students of the Department of Education participated in that phase only. In total, 3 subjects were removed from the data analysis because of false data due to obvious atypical behaviour or as a consequence of technical failures of the equipment during the experiment. The resulting distribution is presented in Table 1.

Table 1: Distribution of the subjects

	LIN	VAR	CROSSED	LS	SL	Total
TO:	22	27	22	0	0	71
PAPP:	12	11	11	10	10	54
BETA:	17	30	16	22	22	107
Total:	51	68	49	32	32	232

Legenda (between brackets: numbers):
TO : Students of the Department of Education (the Dutch name is Toegepaste Onderwijskunde: TO)
PAPP : Students of the Faculty of Public Administration and Public Policy
BETA : Students of the Departments of Computer Science (30), Physics (5), Mathematics (4), Chemical Engineering (21), Electrical Engineering (20), Mechanical Engineering (15), and Business Administration (12)

Subject Characteristics

The following tests were administered, in all cases selected because of possible influence of the pertaining variable on self-chosen segment length:

Group Embedded Figures Test (GEFT): The GEFT was used as this test appears to correlate to the cognitive-style dimension "field dependence" (Witkin, Oltman, Raskin, & Karp, 1971). In the experiment a possible relationship between segment length and field dependence was assumed, as field-independent subjects may have more possibilities than field-dependent subjects to see through the information structure of the experimental video program and tune their stopping places accordingly. Field-dependent subjects may, on the other hand, have problems with the fact that in the VAR and CROSSED conditions the decision where to stop has to be taken by themselves without any guidance from the program (apart from the fact that they know that all presented factual information has to be stored in memory for later recall). This may lead them to play safe by stopping frequently, probably more frequently than field-independent subjects might do.

CLOZE-test: Part of the experimental task of the subjects was to try to remember as much as possible of the "verbal information" that is presented by the video segments. This performance may be influenced by verbal ability. Subjects were ranked in this respect by their scores on a CLOZE test. The CLOZE test used consisted of two short texts in which every fifth word was replaced by an empty space. The total amount of deletions was 91. Subjects had to try to reconstruct the original texts by filling in the right words.

STAR-PLUS-test: This concerns a modification of the familiar sentence-picture comprehension and verification task of Chase and Clark (1972). Pezdek, Simon, Stoeckert, and Kiely (1987) showed that in their experiments good television comprehenders were more likely to utilize an imagery-based strategy for storing information. This result was the reason to test the subjects in the present study with the STAR-PLUS-test, to be able to determine whether the cognitive trait it measures influences preferred segment length[2].

Experimental setting

Three adjacent rooms were used, situated on the first floor of one of the university buildings.

The first room was used for administration by the experimental leader on duty (the researcher or student assistants) and as a relaxation room during the experiments. Also the programr of the project found his workplace here and was continuously available for technical assistance. The subjects were received in this room and used the room to take pauses while working with the experimental program (see the description of the procedure below). Coffee, tea and -- upon request -- hot chocolate were provided. In a corner, special arrangements were made to run the STAR-PLUS test that was administered during the second session. At the back of the room were located the entrances of the other two rooms used in the experiment.

The second room was used for all the paper-and-pencil testing. This test room was equiped with four small tables and four chairs: three for subjects and one for the experimental leader. (No more than three subjects could participate in the experiment at one time, as this is the number of interactive video sets that was available for the experiments.)

The actual experiment took place in the third room. For that purpose, this room was equipped with three interactive video sets each containing an MS-DOS personal computer (Olivetti M240) with a built-in video overlay board (Cameron

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[2] A detailed description of this test goes beyond the purpose of this paper. A complete description is given by Verhagen (in preparation).

MCS), a keyboard and a mouse (Microsoft); a color monitor (Barco CM33); a videodisc player (Philips VP406 or VP410); and headphones (Sennheiser HD-414). Each set was placed on a table with a surface of 1.2 by 1.2 meters. The tables were placed so that the distance between subjects was about 2.5 meters (which respects their needs for privacy according to ergonomic criteria, Oborne, 1987, p199). Screens between the tables prevented subjects to look at the video monitor of a neighbor. The subjects faced windows with dark blue but slightly transparent curtains that allowed some visual contact with a tree-rich parking lot on the university campus. It is believed that this prevented arousal of claustrophobic feelings. Except for the blue curtains and blue adjustable chairs, the dominant colors in the room were shades of grey. The lighting level was adjusted to balance the luminence of the video monitors. It is believed that all these measures together created a friendly atmosphere in which subjects felt at ease.

Procedure

The procedure was the same in all conditions. The experiment took place in two sessions. Session 1 was prepared by switching on the equipment one-half hour before the arrival of the subjects (to reach a stable and qualitatively good colour picture on the rather old video monitors used) and by feeding data about the expected subjects into the computer (name, subject number, experimental condition, age, sex, university department, year of study). After loading these data, the video monitor turned to black, after which the interactive-video sets stood waiting for the subjects.

The subjects arrived at 8:45 (if they participated in a morning session) or at 13:15 (for an afternoon session). (They had been reminded of the first session with a letter that also emphasized that they were expected to appear with a clear mind after a good night's sleep. This letter was sent about one week before the first session.) The session started in the test room with a few words of welcome and a short explanation of the aim of the experiment and the role of the subjects. After this, a pretest was administered that contained just one assignment: "Write down anything you know about the making of cheese". The introductory words and the pretest took together about 10 to 12 minutes (no one subject appeared to be able to describe anything substantial about the cheese-making process).

Next, the subjects were invited to enter the room with the interactive video sets. They were instructed to adjust their chairs to reach a comfortable seating posture and to read a one-page instruction in a version that suited the experimental condition to which they were assigned. This instruction repeated some of the general remarks from the oral instroduction and explained how to work with the equipment. After having observed that everyone had finished reading, the experimental leader asked whether there were questions and answered these in case there were. Next, the subjects were invited to wear the headphones and the experimental leader started the interactive video program by typing a password.

The program instructed the subjects that they were about to watch an introduction about cheesemaking of about 4.5 minutes, which would play without stopping after clicking the mouse. The subjects then watched the introduction which automatically stopped after 4.5 minutes on a freeze frame. Near the bottom of the screen a message was diplayed asking the student to click the mouse to continue. After this, the program instructed the subjects that the introduction would be repeated but that this time they had to work in the manner in which they were expected to work with the main program that followed the introduction.

The subjects then worked through the introduction in one of the ways described before (dependent on the experimental condition). In the VAR and CROSSED conditions, the experimental leader took the opportunity to demonstrate to the subjects what was expected, by showing how to control segment length for a first short segment with a length of three information elements. By working through the introduction the second time, the subjects thus practiced their experimental task. At the end of the introduction the system ceased responding to the subjects, giving instead a message to ask the experimental leader for assistance. The experimental leader then had a short individual conversation with each subject to find out whether he or she understood the task, and gave additional information or reinforcement if necessary. After this, the main program was put into position by again typing a password. At this point, about 20 to 25 minutes had passed since the introduction had been started for the first time.

The subjects worked through the main program, which typically took about 2.5 hours, ranging from less than 2 hours to more than 4.5 hours. Subjects in the LIN condition often needed more time than the others, subjects in the SL and LS conditions less. At the end the program notified the subject to ask the experimental leader what to do next. The subject then was invited to return to the test room and two posttests were administered. The first one consisted of open questions to measure recall, the second one of multiple choice questions to measure recognition. To the second one a questionnaire was attached that asked the subjects about their strategy for deciding at which segment lengths to stop (VAR and CROSSED condition only), what they thought of program-controlled fixed segment lengths (SL and LS conditions only), and their opinion of the program (all conditions)[3]. Taking the tests took about 25 to 30 minutes.

Last, the subjects were sent home with three messages: (a) Reappear in the second session with a clear mind as you did this first time; (b) do not study anything about cheesemaking between this session and the next one; and (c) do not tell your fellow students what has happened here, because they may be in the sample of subjects and every subject should start the experiment without preknowledge of the experimental task.

Session 2 took place three weeks after Session 1 and was completely devoted to testing subjects. The morning session of Session 2 started at 9:15, the afternoon session at 13:45. For most tests, the test room was used. As the second session started later than the first one and was shorter (about two hours in total), all tests could be administered while subjects in session 1 were busy with the interactive video program. The tests were administered in the following order:

- The Group Embedded Figures Test (GEFT)
- A retention test with open questions.
- A retention test multiple-choice questions.
- The STAR-PLUS test (in the first room using the special equipment that was installed there for this purpose).
- The CLOZE test.

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3) The results of the questionnaire are discussed elsewhere (Verhagen, in preparation).

Data analysis.

During their work with the experimental video program, all the actions of the subjects were logged. As a result, the following data were available:

1. All relevant time intervals (watching video, answering questions, pauses, etc.);
2. Starting and stopping points of segments (and thus number of segments and number of information elements per segment);
3. Questions answered correctly the first time.
4. Questions answered correctly the second time (after repetition of the video fragment that followed negative feedback about incorrect first answers).

Next to the data from the program, the scores of all tests were available. All scores were organized in such a way that answers to the questions of the post- and retention tests can be directly related to the pertinent element numbers of the main program.

Results

Background variables

Of the background variables "Age", "Sex", "University Department", and "Year of Study", only Sex and Department appeared to correlate with the research results. However, the number of male and female students was not equal between the different departments. The majority of the subjects from the Department of Education were women, while the technical departments were represented by nearly only male subjects. A multivariate regression analysis revealed that differences between fields of study (educational science, public administration & public policy, technical engineering) explain some of the differences in experimental results, while sex differences do not[4]. Sex differences are therefore not further taken into account in this paper but the differences between the departments are. As can be seen from Table 1, TO students did not participate in the SL and LS conditions, while subjects from the other department are rather equally distributed over all conditions.

Self-chosen segment length

Subjects appeared to differ substantially with respect to the mean of their self-chosen segment lengths. This is displayed in Table 2 and Figure 1.

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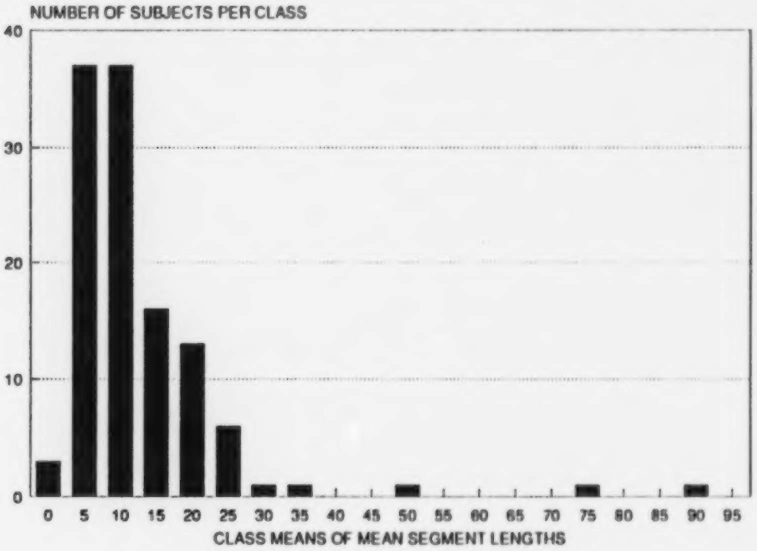
[4] More details can be found with Verhagen (in preparation).

Table 2: Self-Chosen Segment Length and University Department

Department	Mean number of information elements per segment	Standard deviation
TO:	7.42	5.34
PAPP:	13.87	6.67
BETA:	17.66	15.78
Total:	12.70	11.77

Legenda:
TO : Department of Education (the Dutch name is Toegepaste Onderwijskunde: TO)
PAPP : Faculty of Public Administration and Public Policy
BETA : Departments of Computer Science, Physics, Mathematics, Chemical Engineering, Electrical Engineering, Mechanical Engineering, and Business Administration



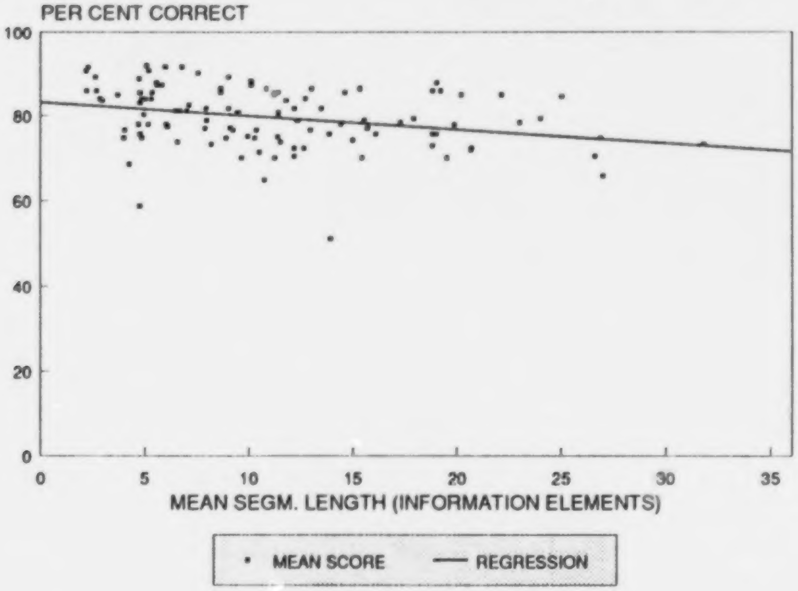
VAR and CROSSED conditions pooled.
Overall mean segment length: 12.19 information elements; standard deviation: 11.77.
Minimum: 2.19 information elements; maximum: 87.50 information elements.

Figure 1: Distribution of means of self-chosen number of information elements per segment

The differences between the mean segment lengths of the students from the different departments appears to be significant ($Chi^2 = 38.61; p<.0001$). Because of the fact that no TO students participated in the SL and LS conditions (Table 1) and the fact that TO students appear to choose shorter segment lengths than students from other departments (Table 2), TO students are only included in analyses where the VAR, CROSSED or LIN conditions are considered. On all occasions where also the SL and LS conditions are at stake, the TO-students are thus left apart.
Although Table 2 shows that the mean segment length of PAPP students and Bèta students are different too, it is assumed that no reason exists to treat PAPP students separately because in all conditions about an equal number of randomly assigned PAPP students were represented.

Within-program performance as a function of self-chosen segment length.

Figure 2 shows the performance of subjects while working with the program as a function of the mean of self-chosen segment lengths.



VAR and CROSSED conditions pooled;
data from all subjects with mean self-chosen segment length < 36 information elements.

Figure 2: Within-program performance as a function of mean segment length

The figure shows for every mean segment length the mean percentage of correct answers to the questions within the program when they were posed for the first time. Only subjects with mean segment lengths shorter or equal to 36 information elements per segment are included. The three subjects with a longer mean segment length (see Figure 1) are considered as outlayers[5].

The regression line for all subjects that describes the relation between the mean of self-chosen segment length in the 'VAR' and 'CROSSED' conditions and the mean percentage of correct answers within the program follows from the equation[6,7]:

$$(\text{MEAN\_SCORE})_{\text{self-chosen length}} = 85.10 - .36*(\text{MEAN\_SEGMENT\_LENGTH\_})$$

The regression analysis explains only 1.5% of the variance in the $\text{MEAN\_SCORE}_{\text{self chosen length}}$ variable.

The values on the X-axis of Figure 2 are means of segment lengths that may be composed of contributions of a wide variety of segment lengths dependent on the variance per subject. The next figure (Figure 3) shows the percentage of correct answers within the program as a function of absolute segment length.

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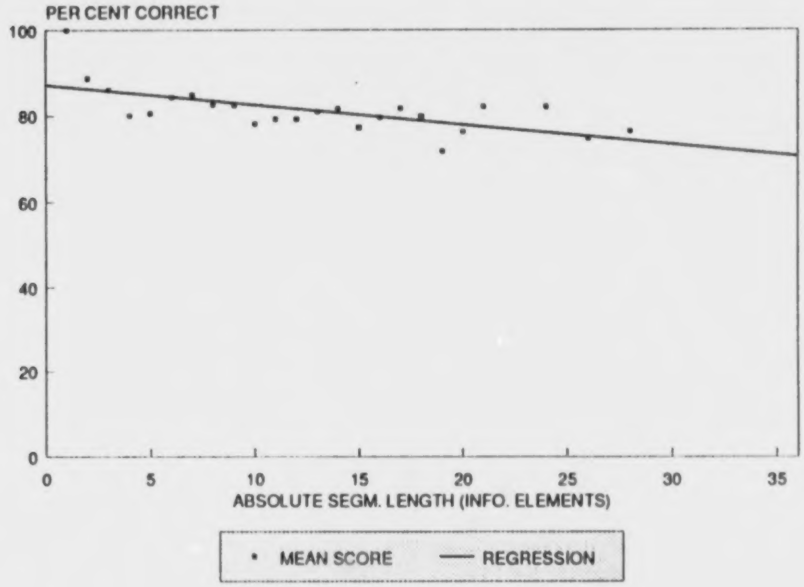
[5] The chosen criterion is that outlayers have mean segment lengths that are longer than the overall mean segment length plus two times the standard deviation. The exact measure is 35.73 (which is 12.19 plus 2*11.77)

[6] In this and the following equations, "SCORE" means "PERCENTAGE OF CORRECT ANSWERS".

[7] "MEAN_SEGMENT_LENGTH" means that the values on the x-axis represent the means of self-chosen segment lengths per subject.



VAR and CROSSED conditions pooled;
only data form subjects that occurred at least 10 times are used in this analysis.

Figure 3: Within-program performance as a function of absolute segment length

To arrive at this figure all segments of one length were pooled, regardless of with which subject a segment was found. Only segment lengths for which at least 10 observations were available were included in the analysis. Per segment length the mean was computed. The resulting values were plotted in the figure with the related regression line. The resulting regression line for all subjects in the 'VAR&CROSSED' combination follows from the equation[8]:

$$(\text{MEAN\_SCORE})_{\text{absolute length}} = 85.48 - .36*(\text{ABSOLUTE\_SEGMENT\_LENGTH})$$

This regression analysis explains 45.9% of the variance in the $\text{MEAN\_SCORE}_{\text{absolute length}}$ variable.

The relation between self-chosen segment length and performance on post tests and retention tests

Figure 4 shows the relation between self-chosen mean segment length and test performance. Only regression lines are displayed. As is clear from the figure, subjects with longer self-chosen segment lengths performed better than subjects who chose shorter ones. The explained variances of the posttests and retention

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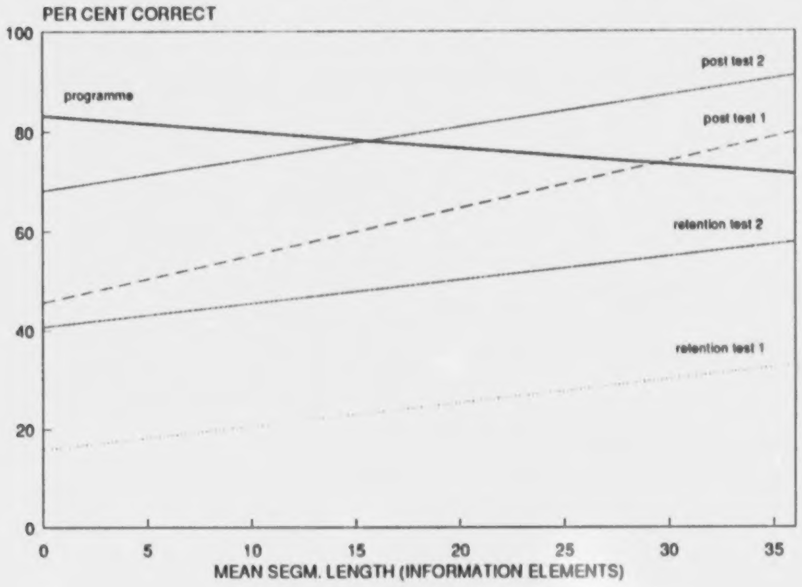
8) See footnote 6.

tests are, however, limited to 18% (Posttest 1), 12% (Posttest 2), 9% (Retention Test 1), and 6% (Retention Test 2).

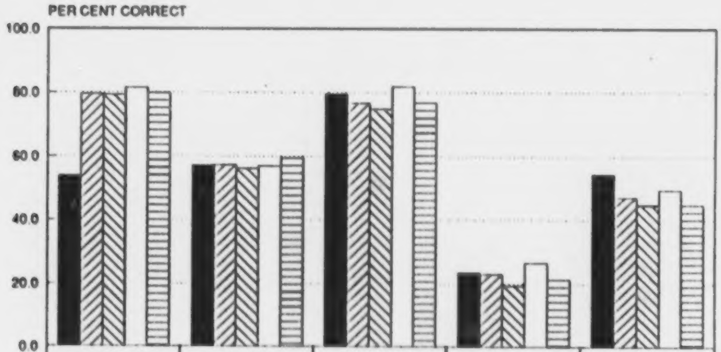


Programme = score on questions within the program.
Data from all students in the VAR and CROSSED conditions.

Figure 4: Test Performance as a Function of Mean Segment Length

Differences in test performance between all conditions

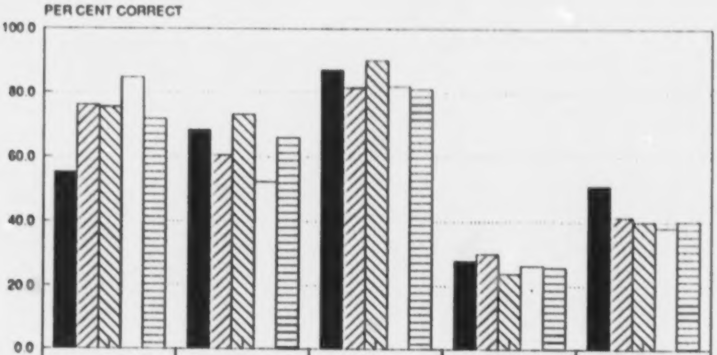
Figures 5, 6, and 7 and Tables 3, 4, and 5 show for all conditions the performance while working with the program and the test results on the posttests and the retention tests. This is done for the program as a whole as well as for the first and second halves of the program separately. This was done to see whether the different treatments per half in the VAR, CROSSED, SL, and LS conditions affected the results.



	PROGRAMME	POSTTEST 1	POSTTEST 2	RET. TEST 1	RET. TEST 2
LINEAR	53.8	57.2	79.4	23.4	54.4
VARIABLE	79.8	57.2	76.5	23.0	47.2
CROSSED	79.3	56.2	74.8	19.4	44.8
SHORT-LONG	81.4	56.9	81.9	26.7	49.6
LONG-SHORT	79.8	59.4	76.7	21.5	44.9

Programme = score on questions within the program. Data from all students except TO.

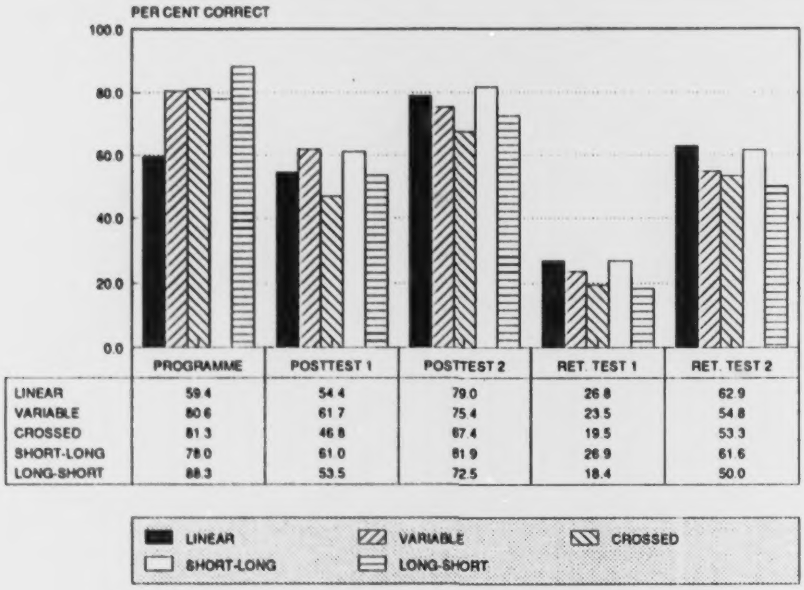
Figure 5: Test Performance by Condition (Whole Program)



	PROGRAMME	POSTTEST 1	POSTTEST 2	RET. TEST 1	RET. TEST 2
LINEAR	55.1	68.3	86.9	27.7	51.2
VARIABLE	76.0	60.5	81.5	29.9	41.3
CROSSED	75.4	73.2	90.0	23.9	39.9
SHORT-LONG	84.6	52.3	81.9	26.4	38.3
LONG-SHORT	71.8	66.0	80.9	25.8	40.1

Programme = score on questions within the program. Data from all students except TO.

Figure 6: Test Performance by Condition (First Half of Program)



	PROGRAMME	POSTTEST 1	POSTTEST 2	RET. TEST 1	RET. TEST 2
LINEAR	59.4	54.4	79.0	26.8	62.9
VARIABLE	80.6	61.7	75.4	23.5	54.8
CROSSED	81.3	46.8	67.4	19.5	53.3
SHORT-LONG	78.0	61.0	81.9	26.9	61.6
LONG-SHORT	88.3	53.5	72.5	18.4	50.0

Programme = score on questions within the program. Data from all students except TO.

Figure 7: Test Performance by Condition (Second Half of Program)

Table 3: Performance Within the Program Compared (all conditions)

Conditions	PROGRAM Whole	Part 1	Part 2
LIN < VAR, CROSSED, SL, LS	**	**	**
SL > VAR, CROSSED		**	
SL > LS		**	
SL < LS			**
LS > VAR, CROSSED			**
LS < VAR		*	

Legend:
The table shows differences in performance level between the conditions with respect to answering questions within the program for the first time. All questions were open questions. Differences were evaluated with a Chi^2 test. Only significant differences are indicated. Part 1 means first half of the program; Part 2 means second half.
*: Level of significance < .05; **: Level of significance < .01

Table 4: Performance on Posttests Compared (all conditions)

Conditions	POSTTEST 1 Whole	POSTTEST 1 Part 1	POSTTEST 1 Part 2	POSTTEST 2 Whole	POSTTEST 2 Part 1	POSTTEST 2 Part 2
LIN > VAR		*				
LIN < VAR			**			
LIN > CROSSED			**			**
LIN > SL		**				
LIN < SL			*			
VAR > CROSSED			**			**
VAR < CROSSED		**			**	
VAR > LS			**			
CROSSED > SL		**			**	
CROSSED < SL			**			**
CROSSED > LS					*	
CROSSED < LS			*			
SL > LS			*			*
LS > SL		**				

Legend:
The table shows differences in performance level between the conditions with respect to post-test scores. Posttest 1 contained open questions that referred to 56 of the information elements of the program. Posttest 2 contained 20 multiple choice questions. Differences were evaluated with a Chi^2 test. Only significant differences are indicated. Part 1 means first half of the program; Part 2 means second half.
*: Level of significance < .05; **: Level of significance < .01

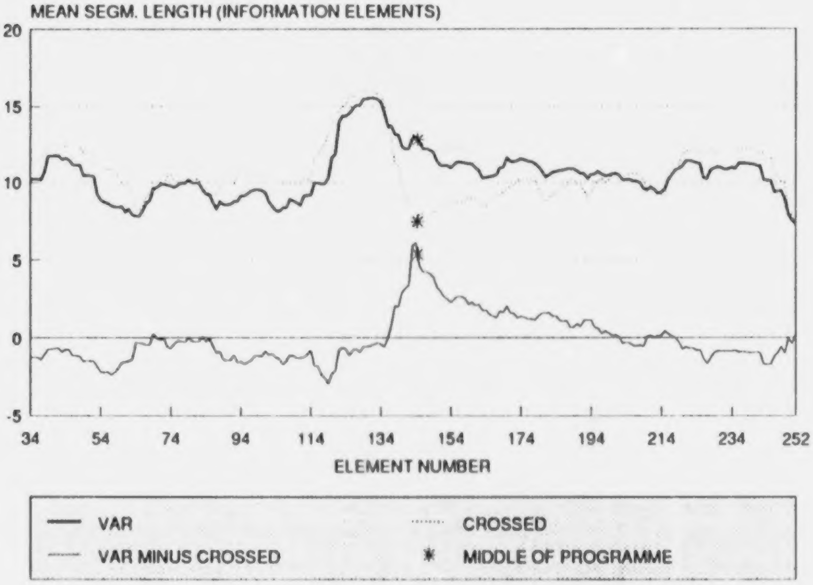
Table 5: Performance on Retention Tests Compared (all conditions)

Conditions	RETENTION TEST 1 Whole	RETENTION TEST 1 Part 1	RETENTION TEST 1 Part 2	RETENTION TEST 2 Whole	RETENTION TEST 2 Part 1	RETENTION TEST 2 Part 2
LIN > VAR				*	*	
LIN > CROSSED	*		**	**	*	*
LIN > SL					*	
LIN > LS			*	**	*	**
VAR > CROSSED	*	*				
CROSSED < SL	*		**			*
CROSSED > LS			**			**
SL > LS			**			**

The table shows differences in performance level between the conditions with respect to retention-test scores. Retention Test 1 contained open questions that referred to 81 of the information elements of the program. Retention Test 2 contained 24 multiple choice questions. Differences were evaluated with a Chi^2 test. Only significant differences are indicated. Part 1 means first half of the program; part 2 means second half.
*: Level of significance < .05; **: Level of significance < .01

Mean segment length as a function of the position in the program

Figure 8 shows the mean segment length as a function of the position in the program. Each information element was part of one segment per subject. This means that every information element was part of as many segments as there were subjects. In Figure 8, the values of Mean Segment Length for each Element Number were computed per element as the mean length of all segments of which an element was a part. This was done for the VAR and CROSSED conditions separately. To be able to observe trends (for instance: Do subjects choose longer segments near the end or just the reverse?), only the data of subjects with 12 segments or more are used in this figure. Figure 8 is also used to discuss fatique effects (Research Question 4).



Only data of subjects with 12 segments or more were used in this analysis.

Figure 8: Mean Segment Length by Element Number

Discussion

Preferred segment length

The first research question asked which segment length learners might prefer if they can choose segment length for themselves. With the present group of subjects the answer is that self-chosen segment length varies over a wide range (Figure 1). Apart from a few extreme scores, mean segments length varies from about 2 to 36 information elements. Although segment length is defined in terms of semantically relevant information elements, it is illustrative to mention the duration of the different segments as they were apparently preferred. The main program has a length of 31.5 minutes and contains 219 information elements.

This leads to a mean length of 8.63 seconds of one information element. The mean of self-chosen segment length thus ranges from about 18 seconds to 311 seconds. Mere preference seems thus to rule segment length.

Segment length and direct recall

The second research question was whether a relation exists between segment length and direct recall and if it makes a difference whether segment length is self-chosen or program controlled. Self-chosen segment length is discussed first.

Figure 2 shows that the mean of self-chosen segment length has only a weak relationship with direct recall. According to the regression line in Figure 2 subjects with a mean segment length of 2 information elements answered about 84% of within-program questions correctly the first time, while subjects with a mean segment length of 36 information elements answered about 72% of these questions correctly. This is a relatively small difference given the difference in mean segment length.

It is, however, true that the regression line from Figure 2 explains only 2.5% of the variance of the performance on within-programme questions. It is therefore interesting to observe that in the given situation Figure 3 suggests that the mean of all scores per absolute segment length is a reasonable predictor of learner performance for that segment length (with an explained variance of almost 46%). The similarity between the lines of Figures 2 and 3 is thereby striking. The small slope of the regression lines reinforces the idea that subjects know for themselves how much information they can handle in one time and decide what segment length to choose accordingly.

The greater precision of absolute segment length may be caused by the fact that subjects make conscious decisions about segment length on a segment-by-segment basis. This may cause much variance in the segments lengths of individual subjects (of which Figures 1 and 2 are derived). It may, however, cause limited variance in performance per segment length if each subject optimally tunes his or her attention, ability, and mental effort to each segment that is presented and chooses the length of that segment accordingly. It has to be noted that subjects with better memories have thereby obviously more possibilities to decide what segment length they prefer. The data suggest that in this respect technical students have the most room to manoeuvre (see Table 2).

The question whether the within-program performance of subjects in the variable conditions differs from the performance in the conditions with fixed segment length can be discussed on the basis of Figures 5, 6, and 7 and Table 3. The VAR and CROSSED conditions show no significant differences in this respect. The subjects in the LIN condition appear however to perform worse than all other conditions (around 55% while all other conditions are doing around 75% to 80%). Answering 213 questions in one time about 31.5 minutes of video obviously is a difficult job.

If the first and second half of the program are considered separately, the SL and LS conditions appear to differ from the VAR and CROSSED conditions and from each other (Figures 6 and 7, and Table 3). SL subjects did better during the first half of the program than subjects in all other conditions, while LS subjects did better during the second half. It is clear that the SL and LS subjects experienced the short segments as relatively easy. The long segments were more difficult for them. LS subjects did significantly worse than the SL subjects during the first half of the program and SL subjects did significantly worse than the LS subjects during the second half. From all other differences, only the different performance of LS subjects and VAR subjects during the first half of the program was significant; the LS subjects did worse than the VAR subjects.

The order of magnitude of the significant differences between the variable conditions and the SL and LS conditions is not impressive. The differences are similar to the differences within the variable conditions according to Figures 2 and 3. The relation between segment length and performance level is obviously rather weak, regardless of the fact whether segment length was self-chosen or program controlled (under the condition that program-controlled segment length falls within the range of self-chosen segment lengths).

Segment length and delayed recall

The third research question asked whether a relation exists between segment length and delayed recall and if it makes a difference whether segment length is self-chosen or program controlled.

Figure 4 shows that subjects with longer mean self-chosen segment length performed better on the post tests and retention tests than subjects who chose shorter segments. This may be caused because these subjects have better memories or because they just preferred longer segments and invested more mental effort to make that choice succesful (not to miss too many questions within the program), which resulted in deeper processing that perhaps paid itself back on the different post- and retention tests. A combination of these two causes is likely.

From Figures 5, 6, and 7 and from Tables 4 and 5 it is apparent that the LIN condition did relatively well as far as the posttests and the retention tests are concerned. One possible explanation for this could be that this is a consequence of the relatively bad performance within the program, which yielded extra exercise due to repetitions of video fragments. This appears, however, not to be true. An extra analysis showed that repetition of video was negatively correlated with posttest and retention-test performance in all conditions (more details can be found in Verhagen, in preparation). It appeared that answering the questions within the program correctly at the first attempt was a good predictor of correctly answering questions about the pertinent information elements in later tests.

An alternative explanation of the good performance of LIN subjects might be that the LIN subjects invested more mental effort, as they knew that they would be questioned about the complete program. Similar to the assumption about the better performance of subjects with longer mean segments in the variable conditions (Figure 4), here also this extra mental effort could have caused better remembering. This idea is reinforced by the fact that the SL and LS conditions yielded relatively low posttest scores for the program halves in which the within-program task was easy (where subjects worked with short segments).

The effect of mental effort has been discussed by Salomon (1984). According to Salomon, the Amount of Invested Mental Effort (AIME) is related to the

Perceived Demand Characteristics (PDC) of a task, and the Perceived Self Efficacy (PSE) for that task. PDC, PSE and AIME can be balanced in many ways, yielding different levels of learning. The performance level while answering questions that a subject considers to be acceptable thereby forms one factor that can be balanced with preferred segment length in the variable conditions. The fact that mean segment length differs considerably in these conditions means that different subjects made different trade-offs with respect to their memory capacity and their willingness to invest mental effort. It may however be that in general subjects in the variable conditions preferred a relatively relaxed approach to their task and thus choosed segment lengths that allowed reasonable performance levels with a moderate AIME. This could explain why LIN subjects, who faced harder PDCs, performed relatively well on the different post- and retention tests. They tuned their AIME to the task and as the task was difficult, their AIME was substantial which caused relatively good storage in memory.

Similar reasoning can be applied to the SL and LS conditions. In these conditions the posttest questions and the retention-test questions were answered relatively well for those halves of the program where the subjects worked with long segments (which was relatively difficult) and relatively badly for the halves where they worked with short segments (and felt no need to invest much mental effort).

In all, the results suggest that designers have much freedom in choosing segment lengths when developing interactive video programs, and also if they decide to use segments with fixed lengths. The point is to inform learners of the PDC of each segment ahead and motivate them to tune their AIME to the needed level. For this, in principle, many audiovisual communication options are available (see again Verhagen, in preparation, for a more detailed discussion of this issue).

A last observation with respect to delayed recall is that ,there appear to be recency effects. This follows from the differences between the scores on the two halves of the program of the VAR and CROSSED conditions in particular, especially where the posttests are concerned. As is apparent from Figures 6 and 7 and from Table 4, the VAR subjects scored better than CROSSED subjects on posttest questions with respect to the second half of the program and worse on questions about the first half, while the scores on the posttests about the program as a whole (Figure 5) showed no noticable differences. VAR subjects saw the second half of the program later than the first half and the CROSSED subjects just the other way around. The mean-time difference between the two halves was about one hour and 15 minutes. The most probable explanation for the different test results is therefore that forgetting starts immediately after learning and that after 75 minutes the forgetting curve is already important enough to cause the observed differences.

Information load as a function of the position in the progam

Under the assumption that the influence of individual differences of subjects will disappear if the mean segment length for each information element in Figure 8 are obtained as the mean of many subjects, the "ideal" curve would be a straight horizontal line. In that case form and content of the program would have no influence on preferred segment length in the sense that the information load of the program would then be perceived to be constant through out.

This appears not to be the case. This is reason to analyse more carefully various formal features of the program such as factors like complexity of narration, mutual influence of picture and sound, use of super-imposed texts, and information load due to technical terms. The analysis of these factors goes beyond the scope of this paper. More information can be found with Verhagen (in preparation). A notable aspect is the occurrence of the peak before the middle of the program. It concerns the only part of the program with an animation sequence. This sequence has however also some repetition of content elements in it. The conclusion that the animation sequence is perceived as more easy as the normal video sequences can thus not be drawn without further analysis.

A clear trend that shows whether subjects decided to take longer segments towards the end of the program or on the contrary chosed shorter ones did not emerge.

Fatigue effects

The last research question was whether fatique effects affect self-chosen segment length. Figure 8 showes that there appears to be no reason to take these into account. The curves of the VAR and CROSSED conditions are very similar with the exception of the dip in the curve of the CROSSED condition round the middle of the program. There is, however, an easy explanation for this. The middle of the program was the forced end of the program for the CROSSED subjects. They thus could not choose the length of their last segment freely. This last segment appeared often to be relatively short, which caused the mean segment length to drop on that place (an effect that can also be observed at the end of the program for both conditions, where the VAR subjects stopped and the CROSSED subjects were half way). Similarly, in the CROSSED condition elements just after the middle could not be part of segments that began before the middle, causing these elements to be part of relatively many short segments. Apart from this, segment length appears not to be substantially different between the VAR and CROSSED conditions. Given the mean time difference of 75 minutes with which VAR or CROSSED conditions arrived at a similar point in the program, it seems that fatigue effects did not affect segment length.

Conclusion

The main results of the study are:

1. Self-chosen mean segment length varies from less than two information elements up to more than 36 information elements, with only a small increase in the amount of wrong answers to questions within the program. Subjects seem to adjust the amount of information they choose to get in one time to their memory capacities and to their willingness to invest mental effort.
2. If a difficult task is expected, subjects seem to adapt themselves by investing more effort. This could be the reason why the subjects in the LIN condition performed relatively well on posttests and retention tests and why subjects in the SL and LS conditions did better in this respect when questions related to that half of the program in which they worked with long segments.
3. No differences are observed between the VAR and the CROSSED conditions which can be attributed to fatique effects. Posttest scores show a recency effect, suggesting that the time difference between VAR and CROSSED of

about 75 minutes yields so much forgetting about the program half that was studied first, that this already affects posttest performance.

The wide variety of preferred length yields little guidance for designers who design interactive video programs with fixed-length segments. The main message may be that quality communication can be accomplished in many forms, whereby different audiovisual formats and segment lengths may appear feasible as long as learners start their tasks with a realistic expectancy of the demand characteristics and can be motivated to tune their mental effort accordingly. A further discussion goes beyond the purpose of this paper. Detailed discussion and further analyses are reported elsewhere (Verhagen, in preparation).

References

Bork, A. (1987). Lessons from computer-based learning. In: D. Laurillard (Ed.), *Interactive media: Working methods and practical applications.* (pp.28-43). Chichester: Ellis Horwood.

Chase, W.G., & Clark, H.H. (1972). Mental operations in the comparison of sentences and pictures. In L. Gregg (Ed.), *Cognition in learning and memory.* New York: Wiley.

Gagné, R.M. (1985). *The conditions of learning and theory of instruction.* (Fourth edition.) New York: Holt-Saunders International.

Keller, J.M., & Kopp, T. (1987). Application of the ARCS model of motivational design. In C.M. Reigeluth (Ed.), *Instructional theories in action: Lessons illustrating selected theories and models.* (pp.289-320). Hillsdale, NJ: Lawrence Erlbaum Associates.

Keller, J.M. & Suzuki, K. (1988). Use of the ARCS Motivation Model in Courseware Design. In D.H. Jonassen (Ed.): *Instructional Designs for Microcomputer.* (pp.401-434). Hillsdale, NJ: Lawrence Erlbaum Associates.

Keller, J.M. (1983). Motivational design of instruction. In C.M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status.* (pp.383-434). Hillsdale, NJ: Lawrence Erlbaum Associates.

Laurillard, D. (1987). Pedagogical design for interactive video. In D. Laurillard (Ed.), *Interactive media: Working methods and practical applications.* (pp.74-90). Chichester: Ellis Horwood.

Merrill, M.D. (1983). Component Display Theory. In C.M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status.* (pp.279-333). Hillsdale, NJ: Lawrence Erlbaum Associates.

Oborne, D.J. (1987). *Ergonomics at work.* Chichester: John Wiley & Sons.

Pezdek, K., Simon, S., Stoeckert, J., & Kiely, J. (1987) Individual differences in television comprehension. *Memory & Cognition, 15* (5), 428-435.

Phillips, T., Hannfin, M., & Tripp, S. (1988). The effects of practice and orienting activities on learning from interactive video. *Educational Communications and Technology Journal, 36,* 93-102.

Romiszowski, A.J. (1986). *Developing auto-instructional materials.* London: Kogan Page.

Salomon, G., (1984). Television is "easy" and print is "tough": The differential investment of mental effort in learning as a function of perceptions and attributions. *Journal of Educational Psychology, 76,* (4), 647-658.

Schaffer, L., & Hannafin, M.J. (1986). The effects of progressively enriched interactivity on learning from interactive video. *Educational Communication and Technology Journal, 34,* 89-96.

Verhagen, P.W. (in preparation). *Length of segments in interactive video programs.* Dissertation. Enschede: University of Twente.

Wager, W., & Gagné, R.M. (1988). Designing computer-aided instruction. In D.H. Jonassen (Ed.), *Instructional designs for microcomputer courseware.* (pp.35-60). Hillsdale, New Jersey: Lawrence Erlbaum.

Witkin, H.A., Oltman, P.K., Raskin, E., & Karp, S.A. *A manual for the Embedded Figures Tests.* Palo Alto, California: Consulting Psychologists Press, Inc.

Title:

Application of Constructivist Theory to the use of Hypermedia

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APPLICATION OF CONSTRUCTIVIST THEORY TO THE USE OF HYPERMEDIA

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Background--Constructivists argue that knowledge is constructed only in the mind of the learner, and that good teaching is not necessarily related to good learning. Bodner (1986) states that "until recently, the accepted model for instruction was based on the hidden assumption that knowledge can be transferred intact from the mind of the teacher to the mind of the learner." He goes on to claim that "teaching and learning are not synonymous; we can teach, and teach well, without having the students learn."

The theory holds (Von Glasersfeld, 1979) that constructivism is facilitated by having the learner identify topics or issues, locate resources, plan investigations and activities, practice self-evaluation, and formulate principles. The emphasis is shifted from these activities as those that teachers do, to those that students should perform.

In contrast to widespread emphasis on instructional technology as "tools for teaching" the emphasis in this study was on using technology as a vehicle for learning. Hypermedia was used to foster constructivism in science and mathematics in K-12 settings. Goals of the study included:

- Students and teachers would gain skill in using computer-based technology

- Students would increase their understanding of math and science

Technology was used as a hook to entice students to learn math and science and to provide an alternative to "read-a-book," "write-a-paper," and "take-a-test." It was hypothesized that students might more readily use primary information sources and texts if the goal were to create a hypermedia program. The reason for emphasizing student production was that, to foster constructivism, students need to display what they learn. As one student said, "You really have to know trigonometry if you're going to develop a program about it."

In every case student producers created the program architecture and completed the content treatment for certain portions of the program. The teacher assisted by providing resources and clarifying questions of content. With one or two elements worked out in detail, remaining portions of each program were left in skeleton form so that other students in the class could complete them. The process of completing an element included using scanned diagrams, digitized sound, written material, and selected footage from videodiscs, based on the nature of the math or science concepts being portrayed.

Method--A consortium was formed of K-12 schools in central Iowa, their Area Education Agency, and the College of Education at Iowa State University. Twelve schools were chosen to participate in the project entitled EMPOWERING STUDENTS WITH HYPERMEDIA, extending from September 1990 to April 1991.

Four in-service sessions were held for teacher/student production teams throughout the year to help them develop scenarios for their programs, and to learn how to use Hypercard, Linkway, and Hyperstudio.

Teachers served primarily as content advisors; students became program designers. University personnel and Area Education Agency collaborators guided teachers and students, conducted in-service sessions, and provided technical advice. It was particularly important to teachers that they choose students who had an interest in the content and in the technology, and who were more or less self starters.

Typical projects included "Cells, Tissues, Organs, Organ Systems," "Examining the Sphere, " and "Reactions of Acids and Bases." The computer programs were created to be open-ended, in that other students in the class could add their own information as they studied the concepts. For example, student producers might develop a "lesson" on the heart, and let it serve as a model for other students who might develop a lesson on the liver or the brain.

Classroom teachers served as content specialists and facilitators for their student production teams, but they did relatively little programming. The main role of the teachers was to guide students through the content of mathematics and science and to suggest resources that students could incorporate into the projects.

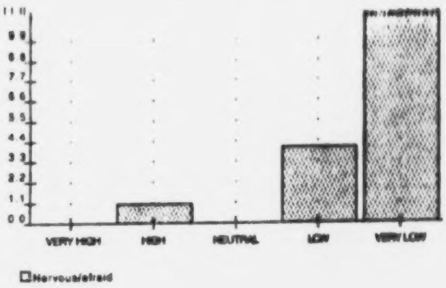
University advisors and Area Education Agency personnel conducted the in-service programs, advised on technical questions, and assisted in purchasing equipment to support the projects.

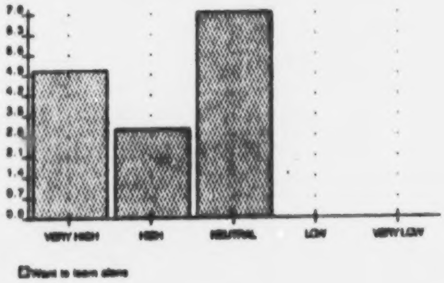
Field Test--Finished programs were used by target students during the period March through May 1991. Data were collected from those students during that time, as well as from the student producers and their teachers (see instruments below). The response from the 12 cooperating schools was not large, probably for two reasons: (1) the specific subject of the computer-based materials may have been covered previously in the year, and (2) the time period for gathering data coincided with the pressure of other activities at the end of the academic year. Thus, information reported here is anecdotal as well as quantitative.

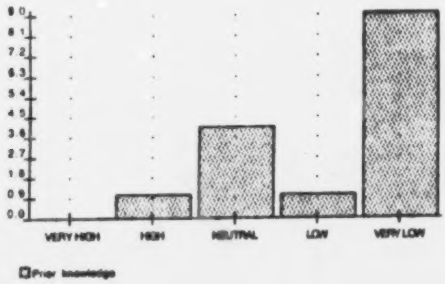
A total of 35 student users, 3 teachers, and 3 student producers responded to the formal instruments.

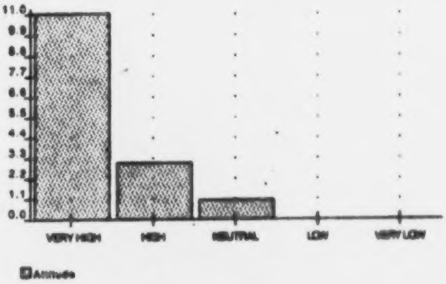
Student users

The following 4 charts depict student attitudes toward technology, their fear of it, their level of knowledge before using the materials, and their preference for working on their own.









Selected responses from student users' indicate the degree of constructivism they may have achieved. When asked to compare traditional instruction (books, TV, field trips, etc.) to this experience, students indicated it was more interesting, they liked it better, they felt it was newer and faster, and they could work at their own pace. "You were the one asking the questions and getting the answers," one student said. Some students wanted "...more pictures and more activities." When asked if they would recommend the program to a friend, virtually everyone said yes.

No rigorous determination was made to determine how much content, in this case physical science, was learned, but students did indicate that they observed how chemicals reacted together, and that reactions were different when acids, water, and bases were used. (The program used was based on a videodisc from the American Chemical Society, showing chemical reactions).

Student Producers

Approximately 50 students across the 12 projects served asprogram designers and programmers. Comments gleaned from informal contact with them during the workshops, from observations their teachers made, and from the formal instruments they submitted indicate that they did most of the work themselves, under the supervision of the teacher. They felt they learned more about the technology than about the content area, and that they enjoyed working alone or as part of a small design team. They acknowledged the great deal of time needed to produce the program shell, but--as one student said, "...it made me manage my time." They indicated that the technology-based activities helped the content come alive for them, and that they acquired a working understanding of high technology too.

Teachers

Teachers expressed enthusiasm for the motivational aspects of this approach, claiming that some students who had not shown much interest in either technology or math/science now were much more involved in both. They found that their role, as teachers, was more suited to posing questions, helping students find resources, and monitoring progress. Nearly all teachers recognized the shift from traditional teacher-centered instruction to student-based learning.

Conclusions and Future Work

The project was considered successful enough that a second phase is underway for the 1991-1992 school year. The former participants (both teachers and student producers) are serving as mentors to 8 new schools.
An organizational meeting brought mentors and new participants together, where they spent time planning new work with each other.

Some student producers from the first year have been identified in their school systems as "experts" who are designated to work with both faculty and students in the use of instructional technology. Several teachers have contracted on their own to work with neighboring schools to foster the use of technology by providing inservice workshops.

It appears that the locus of control for education can be shifted to students, and that technology provides a mechanism for that to happen.

- REFERENCES -

Bodner, George M. Constructivism: a theory of knowledge. Jl. of Chem. Ed. Vol. 63, No. 10. Oct. 1986

Von Glasersfeld, Ernst. The concepts of adaptation and viability in a radical constructivist theory of knowledge. In New directions in Piagetian Theory. Irving Sigel, Ed. Lawrence Erlbaum Associates, Hillsdale, New Jersey. 1981.

Title:

Feedback, Questions and Information Processing – Pulling it All Together

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Feedback, Questions and Information Processing -- Pulling it all together.**

1992 AECT presentation

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Frase (1970), Rothkoph (1970), Bibiscos (1967), Anderson (1970, 1975) and others have produced a large volume of research that looks at the effect of adding questions (adjunct questions) to text materials to improve learning. In general their findings reflect that prequestions may serve an orienting function if they are placed at the beginning of a text passage, facilitating selective attention. The researchers reach this conclusion because the subjects in the research tend to remember information related to the questions than other "incidental" information in the text. However, there is a fair amount of research that finds no facilitating effect for inserted prequestions. One reason, perhaps, is that the learner does not remember the prequestions long enough for them to be of any use in the text. Another possible reason is that the questions cue the learner as to what the text is about but they are just not interested enough in the content to devote the effort needed to learning it.

Likewise the effect of questions following the text and questions inserted in the text have been studied with contradictory results. In general it has been found that questions placed after text materials facilitates long-term recall of information about the text. Subjects given prequestions seem to learn more "incidental" material than those given postquestions, and they seem to do better on inferential questions as opposed to detail questions. The researchers hypothesize that post-questions serve a rehearsal function that facilitates recall.

Research on feedback has looked at many different independent variables including type of feedback, timing of feedback, placement of feedback, and the learner's degree of confidence in responding. Dependent variables include the number of questions answered correctly on a post-test that were missed in the material, the number of correct in the material missed on the post-test, and the response patterns correlated with response certainty. Most of the research in this area is limited to verbal learning tasks, and the few related to concept learning tasks show no significant differences. The findings, in general show feedback to be superior to no feedback, but show very few differences that can be attributed to the type of feedback. Kulhavy (1977) reports finding what he calls a delayed retention effect, which appears if the feedback is massed at the end of the instruction rather than given immediately after the response. He hypothesizes that immediate feedback activates an interference effect caused by a discrepancy between the student's answer and the correct answer. This interference is reduced or eliminated through the use of delayed feedback, however, it is moderated by other variables like response certainty.

How is the research on questions and the research on feedback related? There is virtually no reference of one set of literature in the other yet both may looking at similar phenomenon. We believe there is a connection between question research and feedback research findings that can be viewed from an information processing perspective.

Atkinson and Shiffrin (1968) , Gagné (1985) , and Kumar (1971) have identified "stages" of information processing. Research on learning has typically investigated the effects of instructional intervention on one or more of these stages. For example, research on adjunct questions has focused on the stage Kumar refers to as selective attention, whereas pre-instructional strategies such as providing learning objectives seems to focus on stimulus perception through the arousal of expectations. Considering that questions may serve different roles in instruction, depending upon the stage of information processing they impact, it is reasonable to expect that feedback might serve different purposes, as well.

*** This paper is abstracted from a chapter in Interactive Instruction and Feedback, edited by J. V. Dempsey and G. Sales, Educational Technology Publications, in press.*

It is helpful to identify a model of information processing to use in the organization of question and feedback effects. The model we use is taken from Gagné (1985) which is based on Atkinson and Shiffrin's (1968) model This model postulates features such as sensory registers, short-term memory, long-term memory and an executive control mechanism.

Information processing is set into effect when something from the learner's environment stimulates the learner and activates receptors which transmit information to the central nervous system. After a brief registration in one of the sensory registers, it is transformed into recognizable patterns put into short-term memory (STM). This transformation is referred to as selective perception. Storage in the STM has a relatively brief duration, usually less than 20 seconds, unless some sort of rehearsal takes place. Additionally, STM is limited in its capacity: only a few separate items can be kept in STM at one time. In order that information can be remembered for longer periods and in larger quantities, it must be semantically encoded to a form that will go into long-term memory (LTM). Both information from short-term and long-term memory may be passed to a response generator and is transformed into some sort of action. The message serves to activate effectors which result in a performance that can be observed to occur in the learner's environment

Although these processes are internal to the learner, there are external events -- events outside the learner -- that can be made to influence the processes of learning. The nine events include:

1. Gaining attention,
2. Informing learner of the objective,
3. Stimulating recall of prerequisite learning,
4. Presenting the stimulus material,
5. Providing learning guidance,
6. Eliciting the performance,
7. Providing feedback about performance correctness,
8. Assessing the performance, and
9. Enhancing retention and transfer.

It is to these nine events of instruction that we will address the issue of questions and any ensuing feedback. It is our contention that questions and feedback may serve different functions according to which event of instruction -- that is, to which internal process -- they are being used to enhance.

Event 1: Gain Attention. Attention usually involves the two processes of (1) orientation of the receptors toward the stimulus and (2) the encoding of the stimulus (Anderson, 1970), only the first of these two processes relates to this first stage of information-processing. Although the process of gaining attention is thought of as an initial event, control of attention within the lesson has been found to be important when students are bored, tired, or under pressure to work quickly, as well (cited in Anderson, 1970). Questions presented as a stimulus for attention arousal will not guarantee that what is to follow will be learned. Unless this attention arousal does occur, however, there will not be adequate reception of the stimuli by the receptors to allow for the other processes to occur. Feedback for attention questions is probably rhetorical, if given at all. It may be desirable to allow students to express answers without confirmation of correctness if the object is to create cognitive dissonance or information search, for example, starting a class by asking, "Why are more men bald than women?" Attention questions might increase uncertainty about what the learner already knows, creating epistemic curiosity. In this case, there is no need for feedback because the purpose of the event is to have the student seek the answer to the question in the subsequent instruction. Table 1 below shows how other events might be treated with regard to feedback.

Table 1.
Recommendations for the use of questions and feedback related to stages of information processing

Function of the question	Function and type of feedback
1. Gaining Attention	1. Arousal, Create Cognitive dissonance. Open ended questions with no feedback.
2. Inform the learner of the objective.	2. Create an expectancy for performance. Rhetorical questions and didactic answers could be used to inform the student of the objectives.
3. Stimulate the recall of prerequisite learning	3. Bring related knowledge into short-term memory and confirm present knowledge. Questions eliciting analogies with right-wrong or conditional feedback could be used to test the understanding of prerequisites. Pretests may serve the same function (with or without feedback).
4. Present the stimulus material	4. Socratic dialog to have the student deduce what information is needed. Feedback takes the form of confirmation of responses, and probing questions to guide inquiry
5. Provide learning guidance	5. Questions provide for modeling component parts of the skill being learned. Feedback should show correct answers for analysis by the student.
6. Elicit the performance	6. Questions recall learned skill or components of the learned skill to test for misunderstanding. Feedback should be remedial, directed at the misunderstanding if possible.
7. Provide feedback	7. Feedback should be chosen to fit the purpose that the question is serving in the instructional process. It is possible that the type of feedback should vary with the learners performance and confidence. Give knowledge of correctness and remediation for incorrect answers.
8. Assess performance	8. The purpose is to inform the student of progress toward mastery. Feedback should inform the student of the adequacy of his or her performance.
9. Enhance retention and transfer	9. Provide for spaced practice of the newly learned skill in an authentic situation. Immediate feedback as to correctness would seem most appropriate.

Event 2: Informing the Learner of Objectives. Questions may serve the same purpose as behavioral objectives when they they activate a process of executive control. This is supported by the notion that schemas control perception and that activating these schemas through questions can affect selective perception (West, Farmer, and Wolff, 1991).

Sagerman and Meyer (1987) found a learning effect that resulted from the type of adjunct questions presented after a passage of text. Learners given verbatim questions (i.e., questions in which the learner was asked to recognize a sentence presented in the text) seemed to focus on verbatim details for subsequent passages. Learners who received conceptual questions (i.e., questions that require inferring an answer from information in the text), by contrast, did better on posttest conceptual questions than the verbatim group. This effect, which has been referred to as forward transfer, or specific forward effect (Rickards, 1979), is similar to the effect found by researchers of performance objectives. Faw and Waller's (1976) review of the objectives literature found that (specific) objectives focus attention and improve performance on test items related to those objectives but depress performance on incidental items. When combined with Rickards' (1979) findings, it may be that the type of objective (detailed or general) might affect subsequent processing of the passage more than the content, since it is unlikely that the learner will keep all the objectives in mind while reading.

Event 3: Stimulate the Recall of Prerequisite Learning. After the sensory registers have recorded the information, selective perception takes place for storage in short-term memory. The function of questions during this stage would be to aid the student in recalling prerequisites into short-term memory in order to enable integration of previously learned information with new information or skills.

What is learned, in most instructional situations, depends a great deal on the activities of the student. Rothkopf (1970) calls behaviors that give birth to learning "mathemagenic" behaviors. Similarly, Kumar (1971) points out that which information that is transferred to short-term memory or long-term memory depends on the learner and a set of processes under the learner's control. These processes, termed "control processes" (Atkinson & Shiffrin, 1968) include the process of selective attention. The learner can selectively extract information according to his or her perceived importance of the information. This results in a reduction of the information present at initial registration, since only selected aspects are focused upon (Kumar, 1971).

Event 4: Presenting the Stimulus Material. Questions may be used to enhance the presentation of the insructional stimulus. Short-term memory (STM) is limited both in duration and capacity. It is generally recognized that storage of information lasts no more than 20 seconds (usually less), and capacity consists of about seven units of information at a time (Miller, 1956; Kumar, 1971). However, the duration of information in STM can be increased through rehearsal, and capacity can be increased by chunking.

Questions at this stage can serve to maintain and renew the items stored in short-term memory. They may also aid learners in organizing information into manageable chunks or propositions. Feedback would serve to confirm the adequacy of rehearsal strategies or the propositions and provide reinforcement. Prompts or cues might be used to aid in the process of chaining and linking various sequential chunks together (Anderson, 1970). These hints could then be faded as the student becomes more proficient in the task. Prompts help the learner respond correctly to a question by focusing attention on relevant stimuli (W. Wager & S. Wager, 1985). Two recognized types of prompts include (1) formal prompts, such as spaced blanks in questions which denote the length of the answer, and (2) thematic, contextual, or grammatical cues. Questions with prompts probably work by decreasing cognitive load during early stages of learning, and aid encoding by providing for rehearsal and repetition.

Event 5: Provide Learning Guidance. Information which has successfully been maintained in short-term memory must be semantically encoded for storage in long-term memory. Questions may be used at this stage to encourage learners to integrate new knowledge into existing cognitive structures. Andre (1979) distinguishes two distinct memory stores within long-term memory: (1) episodic memory, which contains a record of events encountered and (2) semantic memory, which contains abstracted or generalized knowledge such as concepts, principles, rules, and skills that are broader than specific episodes. He suggests that this knowledge is represented as schema in semantic memory and that semantic memory consists of a network of interrelated schema. He also estimates that higher-level questions influence the nature of the representation that is formed when learners acquire new information in semantic memory. Kumar (1971) also suggests that encoding may be the same thing as schematizing. The addition of new knowledge to existing memory schemas is referred to as accretion, the most common mode of learning (Norman, 1982).

Questions may reduce the variance in processing information, thereby enabling or facilitating rapid encoding (Miller, 1956). For example, in a rote memorization task of memorizing a list of words, the way in which a question is constructed can aid in more rapid encoding of the task. Consider the following list of words:

APPLE
CHAIR
PANTS
ONION
CHERRY
TABLE
SHIRT
CARROT
ORANGE
PLATE
SHOES
POTATO

To successfully memorize the list in 30 seconds may prove somewhat difficult. However if a student is asked to memorize the words as presented in a new list -- one in which the words have been put into sets which allow for them to be remembered according to some sort of prior schema -- the words are much easier to successfully memorize in the allotted 30 seconds:

Categories

SHIRT
PANTS
SHOES

TABLE
CHAIR
PLATE

CARROT
ONION
POTATO

APPLE
ORANGE
CHERRY

However, the group given the first list with the question, "What four categories of things can the following list be sorted into?" should be able to produce the second list for themselves. Reigeluth (1983) describes this as strategy activation. If questions cause a forward transfer effect, as described by Sagerman and Meyer (1987), these types of questions might build a stronger use of strategies in future learning, at least for students who are able to apply the strategy.

Feedback given in response to questions which serve to aid in semantic encoding can validate the integration of new information with pre-existing knowledge or it may serve to equalize question links between existing structures and new structures even further. Feedback also may serve as learning guidance through the demonstration of processes. Elaboration in feedback provides the opportunity for additional information to be stored.

In fact, elaborations provide redundancy in the memory structure which can act as a safeguard against forgetting and as an aid in fast retrieval (Reder, 1980).

Event 6: Elicit Performance. Questions can be used to activate response organization. According to Bartlett (cited in Kumar, 1971), "a schema is an active organization of past experiences" (p. 403). Although schemas may be different, they are still interconnected by common factors in an organized way. The process of reconstruction activates a number of relevant schemas to recreate the event (Kumar, 1971). Questions can act to help in this process of reconstruction by cueing these relevant schemas.

Post-questions act as confirmation for important mathemagenic behaviors, maintaining appropriate responses on succeeding portions of text (Frase, 1970). Questions can test for understanding or misunderstanding. Questions can also act to reinforce learning behaviors. Feedback acts to remediate misunderstanding and to provide spaced reinforcement.

Hamaker (1986) suggests that students receiving feedback to adjunct questions may adopt a passive attitude toward the questions because they know the correct answer will eventually be presented. This would imply that feedback would limit the amount of information search engaged in by a student and lead to a lower level of incidental learning.

Event 7: Provide Feedback. When a response is generated, the learner attempts to confirm the correctness or appropriateness of the response. Feedback serves to provide reinforcement and corrective information to the student which in turn works to provide cues for future performance. Feedback can address whether or not the question was correctly interpreted and whether or not the answer was adequate. Probably the most important role of feedback at this stage is to correct misunderstandings.

Event 8: Assess Performance. Performance via a posttest or retention test is probably the most common way of using questions. Assessing whether or not the task can be performed gives the opportunity for reinforcement and/or validation through variations in context. Feedback confirms that the skill has been generalized to a range of situations.

Event 9: Enhance Retention and Transfer. Knowledge transfer, at the most general level, involves change in the performance of a task as a result of the prior performance of a different task. The difference between "transfer" and "learning" is that in the case of transfer, the two tasks are said to be "different." In transfer paradigms, the "different" task is usually selected to be novel to the student (Gick & Holyoak, 1987). The encoding of a training task will aid subsequent transfer to the extent that the learner has acquired rules that will be applicable to a range of different tasks with "structural commonalties." According to Gick and Holyoak (1987), "if the transfer task evokes similar goals and processing mechanisms, or has salient surface resemblances to the training task, these common components then serve as the basis for retrieval of the acquired knowledge in the transfer context" (p. 40).

One important influence cited as affecting the encoding of the training task is direct feedback about performance levels (Gick & Holyoak, 1987). Feedback can provide guidance and cues as to which rule to apply in certain transfer problems. Similarly, questions which invoke certain commonalties to be recognized and appropriately corresponding rules to be applied can serve as a vehicle for transfer.

Summary

Questions and Feedback are inextricably related. Recently the process-product paradigm research on questions was compared to a sociolinguistic perspective (Carlson, 1991). Carlson argues that the meaning of questions is dependent upon their context in discourse, and that the content of questions cannot be ignored. Some of Carlson's criticisms of research on classroom questions seem pertinent also for research on feedback. Feedback is always related to a response generated by a question. In this sense, the meaning of feedback is dependent upon its context in the instruction. Feedback effectiveness may also be dependent upon certain learner variables, such as the learner's confidence in his or her answer. But these personal factors influencing feedback's effectiveness may vary according to the type of learning task involved (see Mory, 1991) and may very well have fluctuating influences within each stage of information-processing, as well.

In this paper, we have attempted to show how questions serve a variety of roles in the learning process, and so it is reasonable to postulate that feedback also serves different purposes at different stages in learning. Table 1 provides some examples of how the role of the question might determine the appropriate type of feedback. It seems unlikely that we will find any universal agreement on the "best" type of feedback. One has to ask "Feedback for what?", and take into consideration the type of question, the stage of information processing, and conditions within the learner to arrive at an answer.

References

Anderson, R. C. (1970). Control of student mediating processes during verbal learning and instruction. Review of Educational Research, 40(3), 349-369.

Anderson, R. C. , & Biddle, W. B. (1975). On asking people questions about what they are reading. In G. Bower (Ed.), The psychology of learning and motivation Vol. 9 (pp. 89-132). New York: Academic Press.

Andre, T. (1979). Does answering higher-level questions while reading facilitate productive learning? Review of Educational Research, 49(2), 280-318.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation, Vol. 2. New York: Academic Press.

Ausubel, D. P. (1968). Educational psychology: A cognitive view. New York: Holt, Rinehart and Winston.

Bull, S. G. (1973). The role of questions in maintaining attention to textual material. Review of Educational Research, 43, 83-87.

Bangert-Drowns, R. L., Kulik, C. C., Kulik, J. A. Morgan, M. (1991). The instructional effect of feedback in test-like events. Review of Educational Research, 61(2), 213-238.

Carlson, W. S. (1991). Questioning in classrooms: A sociolinguistic perspective. Review of Educational Research, 61(2).

Duchastel, P. (1983). Interpreting adjunct question research: Processes and ecological validity. Human Learning, 2, 1-5..

Faw, H. W. & Waller, T. G. (1976). Mathemagenic behaviors and efficiency in learning from prose materials: Review critique and recommendations. Review of Educational Research, 46(4), 691-720.

Frase, L. T. (1970). Boundary conditions for mathemagenic behaviors. Review of Educational Research, 40(3), 337-347.

Gagné, R. M. (1985). The conditions of learning (4th ed.). New York: Holt, Rinehart, and Winston.

Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). Principles of instructional design (4th ed.). Texas: Harcourt Brace Jovanovich.

Gall, M. D. (1970). The use of questions in teaching. Review of Educational Research, 40(5), 707-721.

Gick, M. L., & Holyoak, K. J. (1987). The cognitive basis of knowledge transfer. In S. M. Cormier & F. D. Hagman (Eds.) Transfer of learning: Contemporary research and applications (pp. 9-46). San Diego: Academic Press, Inc.

Hamaker, C. (1986). The effects of adjunct questions on prose learning. Review of Educational Research, 56(2), 212-242.

Hamilton, R. J. (1985). A framework for the evaluation of the effectiveness of adjunct questions and objectives. Review of Educational Research, 55(1), 47-85.

Kulhavy, R. W. (1977). Feedback in written instruction. Review of Educational Research, 47(1), 211-232.

Kulhavy, R. W., & Stock, W. A. (1989). Feedback in written instruction: The place of response certitude. Educational Psychology Review, 1(4), 279-308.

Kumar, V. K. (1971). The structure of human memory and some educational implications. Review of Educational Research, 41(5), 379-417.

Ladas, H. (1973). The mathemagenic effects of factual review questions on the learning of incidental information: A critical review. Review of Educational Research, 43(1), 71-82.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. The Psychological Review, 63(2), 81-97.

Mory, E. H. (1991). The effects of adaptive feedback on student performance, feedback study time, and lesson efficiency within computer-based instruction (Doctoral dissertation, Florida State University, 1991).

Mouton, H., & Reigeluth, C. M. (1987). Adjunct questions and mediated self instruction: Comparisons of lookback and no-lookback procedures, with high or low level questions, massed or inserted in the text. (IDD&E Working Paper No. 24). Syracuse, NY: Syracuse University, School of Education. (ERIC Document Reproduction Service No. ED 289 471)

Norman, D. A. (1982). Learning and memory. New York: W. H. Freeman and Company.

Reder, L. M. (1980). The role of elaboration in the comprehension and retention of prose: A critical review. Review of Educational Research, 50(1), 5-53.

Reigeluth, C. (1983). Meaningfulness and instruction: Relating what is being learned to what a student already knows. Instructional Science, 12, 197-218.

Reynolds, R. E., & Anderson, R. C. (1982). Influence of questions on the allocation of attention during reading. Journal of Educational Psychology, 74(5), 623-632.

Rickards, J. P. (1979). Adjunct postquestions in text: A critical review of methods and processes. Review of Educational Research, 49(2), 181-196.

Rothkopf, E. Z. (1970). The concept of mathemagenic activities. Review of Educational Research, 40(3), 325-336.

Rothkopf, E. Z., & Bisbicos, E. E. (1967). Selective facilitative effects of interspersed questions on learning from written materials. Journal of Educational Psychology, 58(1), 56-61.

Rothkopf, E. Z., & Kaplan, R. (1972). Exploration of the effect of density and specificity of instructional objectives on learning from text. Journal of Educational Psychology, 63(4), 295-302.

Sagerman, N., & Meyer, R. (1987). Forward transfer of different reading strategies evoked by adjunct questions in science text. Journal of Educational Psychology, 79(2), 189-191.

Sternberg, S. (1969). The discovery of processing stages: Extension of Donder's method. Acta Psychologica, 30, 276-315.

Wager, W., & Wager, S. (1985). Presenting questions, processing responses, and providing feedback in CAI. Journal of Instructional Development, 8(4), 2-8.

Washborne, J. N. (1929). The use of questions in social science material. Journal of Educational Psychology, 20, 321-359.

West, C. K., Farmer, J. A. & Wolff, P. M. (1991) Instructional design: Implications from cognitive science. Englewood Cliffs, NJ: Prentice Hall.

Title:

Designing the Instructional Environment: Focus on Seating

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Designing the Instructional Environment: Focus on Seating

Carol S. Weinstein

Not too long ago, I visited a fifth-grade class to observe a student teacher. I had heard a great deal about how the children in this class made extensive use of the computer for writing. According to the student teacher, all the children had their own disks, and using Appleworks, they wrote, edited, and revised their stories. Eventually, the stories were "published" and became part of the class' personal library. The computers remained on all day, and students moved to the computer area at assigned times or whenever they had a free moment.

As I entered the classroom, I could see three computers against the back wall, each in its own narrow carrel. The dividers were clearly intended to ensure that the individual working independently at each computer wouldn't be distracted by neighbors. However, two students sat at each computer, crowded together, working on collaborative writing activities. As I watched, I saw some interesting "giraffe-like" behavior: the students at each computer would stretch their necks up and around the carrel dividers, trying to see what was going on next door. Furthermore, other students walking by (on their way to the pencil sharpener or the waste basket) would stop and peer over the shoulders of the students at the computer. They'd comment on what appeared on the screen, offer suggestions, correct spelling, and ask questions. At times, quite a cluster would form in the computer area.

Observing all this interaction, I recalled—with a smile—the early fears educators had voiced about microcomputers leading to individual isolation—fears that have certainly not been borne out. As Celia Genishi (1988) has observed, computer use is often "a social event" (p. 197). Clearly, computers *can* generate increased collaboration among children (Borgh & Dickson, 1986; Dickinson 1986, Hawkins et al., 1982; Wright & Samaras, 1986). One reason for this increased collaboration is the public nature of the computer screen. Another reason is the fact that in most classrooms, as in the one I was visiting, computers are a scarce resource, so teachers often assign children to work in pairs or in small groups.

I've begun with this anecdote to point out the *mismatch that sometimes occurs between instructional goals and physical settings*. The teacher in this classroom actively encouraged collaborative writing; she often assigned students to work on stories together; she encouraged group problem-solving around the computer; and she didn't mind when students passing by stopped to see what was on the monitor. Yet the physical setting was not designed for this interaction and collaboration; in fact, it was intended to promote individual, independent task activity. The narrow carrels prevented two students from sitting comfortably in front of each computer; the computer area was immediately adjacent to students' desks, so students working on the computer needed to be quiet in order to prevent others from becoming distracted; and the aisle in front of the computer area was narrow and not suitable for group activities around a monitor.

When this kind of mismatch occurs, it underscores the need for those who design and carry out instruction--teachers, curriculum developers, instructional designers, trainers--to attend to the physical setting in which instruction will occur and to think seriously about the way design features can support or hinder instructional goals (Weinstein, 1981). Too often, discussions of physical settings focus solely on lighting, acoustics, the size and shape of the room, and the location of electrical outlets--the fixed features--and ignore environmental variables that can be manipulated by users, like furniture arrangement, clarity of pathways through the space, amenities, and provisions for privacy.

As my student teacher's story suggests, one physical variable that needs to be examined is seating arrangement and its impact on interaction among students. We must ask ourselves, "Given this physical setting, how much interaction is likely to occur?" "How much interaction do I wish to foster?" "What kind of interaction do I want to foster: conversation, group problem solving, tutoring?" "How do I want the interaction to flow?" The answers to these questions should influence the way we design the space and, in particular, the seating arrangement we choose. We know that different seating arrangements--horseshoes, rows, clusters of desks, tables--can affect interaction and task attention (Weinstein, 1984). Let's consider briefly about what is known about some of these common seating arrangements.

A number of studies have compared students' behavior when they're seated in the traditional row-and-column arrangement with their behavior when they're seated in clusters or around tables. For example, a 1983 study (Bennett and Blundell, 1983) placed 10- and 11-year-old students in a small group seating arrangement, then in rows, then once again in groups. The results indicated that the quantity of work completed increased when students were in rows, although the quality of work remained the same. The teachers also reported that there was a noticeable improvement in classroom behavior when the students were in rows.

These findings are consistent with earlier work (Wheldall, Morris, Vaughan, & Ng, 1981; Axelrod, Hall, & Tams, 1979), which found that elementary students seated in rows exhibited greater on-task behavior than students clustered around tables. It seems clear that when the instructional goal is to have students complete individual tasks, it is unwise to place them in clusters. In fact, I tell my students that it is inhumane to place students in clusters and then tell them that they may not interact. Whenever I see this situation, I am reminded of Phil Jackson's (1968) very astute comments about life in elementary classrooms:

> ....students must try to behave as if they were in solitude, when in point of fact they are not....in the early grades it is not uncommon to find students facing each other around a table while at the same time being required not to communicate with each other. These young people, if they are to become successful students, must learn how to be alone in a crowd. (p. 16)

On the other hand, when the instructional goal *requires* students to interact--for example, in cooperative learning situations and large group discussions--tables, clusters, squares, and circles are definitely preferable to rows. Peter Rosenfield, Nadine Lambert, and Allen Black (1985) compared fifth- and sixth-graders' discussion behavior in three arrangements--rows, clusters, and circles. They found circles were better for discussion than clusters, and clusters were better than rows, which produced more withdrawal and off-task behavior. One interesting observation was that the cluster arrangement encouraged students to raise their hands when they had a comment, whereas students seated in circles more often made spontaneous "out-of-order" comments.

It's not difficult to see why arrangements like circles and clusters would be superior to rows for discussion. Having individuals sit face-to-face promotes social interaction by providing opportunities for eye contact and non-verbal communication (e.g., gestures and facial expressions). Row formations, on the other hand, minimize social contact and thus help to focus individuals on the tasks at hand.

In addition to examining differences in interaction among seating arrangements, researchers have also looked at patterns of interaction *within* arrangements. For example, when individuals are seated in a circle, they are most likely to make a comment immediately after an individual seated directly across the circle, and they rarely speak to persons beside them (Steinzor, 1950). Similarly, when students are seated in a square, there is more participation from people directly opposite the instructor than from those at the sides, and students sitting adjacent to the instructor generally remain silent (Sommer, 1967). Again, greater opportunity for eye contact and non-verbal communication appear to be responsible for this pattern of interaction.

A comparable phenomenon occurs in row-and-column arrangements. The classic study in this area was done by Adams and Biddle in 1970. These investigators found that students who sat in the front and center of the room interacted most frequently with the teacher (assuming the teacher was in the front and center of the room). The effects were so dramatic that Adams and Biddle called this area the "action zone." Apparently, the action zone phenomenon is not just a matter of the more interested, more eager students choosing seats in the front. Although the research is not completely consistent, there is evidence that even when seats are randomly assigned, those in the front tend to participate more. Furthermore, research (Schwebel & Cherlin, 1972) has indicated that when elementary students are moved up to the front, they become more attentive. Whether it is increased eye contact with the teacher or the feeling that one is under closer surveillance, a seat in the front-center of the classroom does appear to facilitate participation (see Montello, 1988, for an excellent review of these studies).

In addition to influencing the flow of communication, seating position may affect an individual's perceived leadership ability. Howells and Becker (1962), for example, seated five-person groups at a rectangular table, with two people on one side and three people on the other. Since the two individuals on one side could influence three individuals, and those on the three-seat side could influence only two, the investigators hypothesized that members of the two person side would emerge more frequently as leaders. The data confirmed this prediction--14 people emerged as leaders from the two-seat side, compared with six from the three-seat side.

What does all this mean for instructional design? The first lesson is *that the physical setting in which instruction occurs is not simply a neutral backdrop*, without influence or importance. Indeed, the physical setting will affect learners' behavior, whether we intend it to or not in the instructional design. These effects occur in two ways--*directly*, by the behaviors the setting allows, and *indirectly or symbolically*, by the messages the setting communicates about what behaviors are permitted, how important learning is, and what the roles of the learner and teacher should be (Proshansky & Wolfe, 1974). Let me give an example. We know that if individuals are seated facing each other in clusters, they are able to carry on a discussion more easily than if they are seated apart from one another in rows. Thus, discussion is *directly* affected by the arrangement of the setting. In addition, the arrangement may *indirectly* affect behavior by conveying the message that the teacher values discussion and collaboration, that students are *supposed* to talk. If this is indeed the message that the teacher wishes to communicate, all is well and good. If the message is actually contrary to the teacher's wishes, we have a situation where the design of the space contradicts the teacher's instructional goals. In other words, we have a mismatch between environment and intention.

A second lesson is that *teachers, trainers, and instructional designers must consider the direct and indirect effects of various spatial arrangements and determine which formations will maximize the effectiveness of the designed instruction*. If we do not systematically analyze these effects and design a setting to support our goals, we can easily become "victims" of the environment, for it will affect behavior in ways that we did not intend. This process of environmental analysis is somewhat different for those who are preparing instructional materials and those who are providing live instruction. As Tessmer and Harris (1992) have observed, designers are not present to arrange seating when materials are used, so they must anticipate the environment in which the activity will take place and provide some guidance on seating arrangements in instructor or student manuals.

Fred Steele (1973) has coined the term "environmental competence" to refer to an awareness of the physical environment and its impact and the ability to use or change that environment to suit one's needs. Environmentally competent teachers and designers do not assume that programs, materials, and activities will be equally effective in any instructional environment. They do not leave the design of instructional settings to custodians--who far too often are responsible for the way our instructional settings are arranged. Instead, they ask: What will the learners be doing? Will they be reading or writing independently, will they be engaged in cooperative learning activities, will they be watching a videotape, will they be collaborating in pairs at a microcomputer? And then they design a physical arrangement that supports these activities, making *environmental design* an integral part of their *instructional design*.

References

Adams, R. S., & Biddle, B. J. (1970). Realities of teaching: Explorations with video tape. NY: Holt, Rinehart, & Winston.

Axelrod, S., Hall, R. V., & Tams, A. (1979). Comparison of two common classroom seating arrangements. Academic Therapy, 15(1), 29-36.

Bennett, N. , & Blundell, D. (1983). Quantity and quality of work in rows and classroom groups. Educational Psychology, 3, 93-105.

Borgh, K., & Dickson, W. P. (1986). Two preschoolers sharing one microcomputer: Creating prosocial behavior with hardware and software. In P. F. Campbell & G. G. Fein (Eds.), Young children and microcomputers. Englewood Cliffs, NJ: Prentice-Hall.

Dickinson, D. K. (1986). Cooperation, collaboration, and a computer: Integrating a computer into a first-second grade writing program. Research in the Teaching of English, 20, 357-378.

Genishi, C. (1988). Kindergartners and computers: A case study of six children. Elementary School Journal, 89, 185-201.

Hawkins, J., Sheingold, K., Gearhart, M., & Berger, C. (1982). Microcomputers in schools: Impact on the social life of elementary classrooms. Journal of Applied Developmental Psychology, 3, 361-73.

Howells, L. T., & Becker, S. W. (1962). Seating arrangement and leadership emergence. Journal of Abnormal and Social Psychology, 64, 148-150

Montello, D. R. (1988). Classroom seating location and its effect on course achievement, participation, and attitudes. Journal of Environmental Psychology, 8, 149-157.

Proshansky, E., & Wolfe, M. (1974). The physical setting and open education. School Review, 82, 557-574.

Rosenfield, P., Lambert, N. M., & Black, A. (1985). Desk arrangement effects on pupil classroom behavior. Journal of Educational Psychology, 77(1), 101-108.

Schwebel, A. I., & Cherlin, D. L. (1972). Physical and social distancing in teacher-pupil relationships. Journal of Educational Psychology, 63, 543-550

Steele, F. I. (1973). Physical settings and organizational development. Reading, MA: Addison-Wesley Publishing Company.

Steinzor, B. (1950). The spatial factor in face-to-face discussion groups. Journal of Abnormal and Social Psychology, 45, 552-555.

Tessmer, M., & Harris, D. (1992). Analyzing the instructional setting: Environmental analysis. London: Kogan Page.

Weinstein, C. S. (1981). Classroom design as an external condition for learning. Educational Technology, 21(8), 12-19.

Weinstein, C. S. (1984). Seating arrangements in the classroom. International Encyclopedia of Education, 4483-4485.

Wheldall, K., Morris, M., Vaughan, P., & Ng, Y. Y. (1981). Rows versus tables: An example of the use of behavioural ecology in two classes of eleven-year-old children. Educational Psychology, 1(2)., 171-184.

Wright, J. L., & Samaras, A. S. (1986). Play worlds and microworlds. In P. F. Campbell & G. G. Fein (Eds.), Young children and microcomputers. Englewood Cliffs, NJ: Prentice-Hall, pp. 73-86.

Title:

A Critical Review of Elaboration Theory

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A CRITICAL REVIEW OF ELABORATION THEORY

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Elaboration theory (ET) is a model for sequencing and organizing courses of instruction. Developed by Charles Reigeluth and associates in the late 1970s (Reigeluth, Merrill, & Wilson, 1978; Reigeluth, Merrill, Wilson, & Spiller, 1979), ET drew heavily upon the cognitive research on instruction available at the time, in particular the work of Bruner, Ausubel, and Norman (Merrill, Wilson, & Kelety, 1981). Since then, Reigeluth has refined the theory by offering detailed procedures for the planning and design of conceptual (Reigeluth & Darwazeh, 1982), procedural (Reigeluth & Rodgers, 1980), and theoretical instruction (see Reigeluth and Stein, 1983 for an overview and Reigeluth, 1987 for a detailed example). ET has been one of the best-received theoretical innovations in instructional design (ID) in the last 15 years, and is heavily referred to and used by practitioners and researchers. At the same time, research in cognitive psychology has continued to shed light on relevant processes of learning and instruction. Just as models of learning change over time, ID models also undergo regular changes (Merrill, Kowallis, & Wilson, 1981; Rickards, 1978). The purpose of this paper is to offer a critique of ET based on recent cognitive research, and to offer suggestions for updating the model to reflect new knowledge. We believe ID models should undergo such revisions every few years to stay current with the growing knowledge base in learning, instruction, and other areas of research.

ELABORATION THEORY BASICS

ET's basic strategies are briefly summarized below.

1. *Organizing structure.* Determine a single organizing structure for the course which reflects the course's primary focus. This organizing structure may be one of three types: conceptual, procedural, or theoretical. Reigeluth (1987) explains that "In all the work that has been done on sequencing, elaborations based on concepts, principles, and procedures are the only three we have found, although additional ones may be identified in the future" (p. 249). Reigeluth justifies the use of a single organizing structure by suggesting that "careful analysis has shown that virtually every course holds one of these three to be more important than the other two" (Reigeluth, 1987, p. 248). The other two types of content, plus rote facts, "are only introduced when they are highly relevant to the particular organizing content ideas that are being presented at each point in the course" (Reigeluth & Stein, 1983, p. 344).
2. *Simple-to-complex sequence.* Design the course proceeding through the identified structure in a simple to complex fashion, with supporting content added within lessons. Begin with a lesson containing "a few of the most fundamental and representative ideas [taught] at a concrete, application (or skill) level..." (Reigeluth, 1987, p. 248). This first lesson is termed the "epitome"; successive lessons add successive layers of complexity in accordance with the categories of the organizing structure.
3. *Sequencing guidelines.*
   —For conceptually organized instruction "present the easiest, most familiar organizing concepts first" (p. 251).
   —For procedures, "present the steps in order of their performance" (p. 251).

—For theoretically organized instruction, move from simple to complex.

- Place supporting content immediately after related organizing content.
- Adhere to learning prerequisite relationships in the content.[1]
- Present coordinate concepts simultaneously rather than serially.
- Teach the underlying principle before its associated procedure.

4. *Summarizers* are content reviews (presented in rule-example-practice format), at both lesson and unit levels.
5. *Synthesizers* are presentation devices—often in diagram form—designed to help the learner integrate content elements into a meaningful whole and assimilate them into prior knowledge. They help make content structure *explicit* to the student; examples include a concept hierarchy, a procedural flowchart or decision table, or a cause-effect model with nodes and arrows.
6. *Analogies* relate the content to learners' prior knowledge. Effective analogies will tend to bear strong resemblance to the content; weak analogies will contain more differences than similarities with the target content. Reigeluth and Stein (1983) suggest the use of multiple analogies, especially with a highly divergent group of learners.
7. *Cognitive strategy activators*. A variety of cues—pictures, diagrams, mnemonics, etc.—can trigger cognitive strategies needed for appropriate processing of material. Reigeluth and Stein (1983) note that these cues for strategy use may be *embedded*, such as pictures, diagrams, or mnemonics—indirectly "forcing" appropriate processing—or *detached*, such as directions to "create a mental 'image' of the process you just learned" (p. 362). Continued use of these activators can eventually lead students to understand when and where to apply various cognitive strategies spontaneously upon learning materials.
8. *Learner control*. Reigeluth and Stein (1983) believe that "instruction generally increases in effectiveness, efficiency, and appeal to the extent that it permits informed learner control by motivated learners (with a few minor exceptions)" (p. 362). Learners are encouraged to exercise control over both content and instructional strategy. Clear labeling and separation of strategy components facilitates effective learner control of those components. Regarding content, Reigeluth and Stein (1983) claim that "only a simple-to-complex sequence can allow the learner to make an informed decision about the selection of content" (p. 363), presumably because content choices will be meaningful at any given point.

KNOWLEDGE REPRESENTATION

Before turning to sequencing concerns, we discuss the notion of content structure and its epistemological assumptions.

WHAT IS CONTENT STRUCTURE?

The basic idea of content structure—the way content elements are interrelated—is a long-accepted notion in educational psychology (e.g., Bruner, 1966). However, the nature of content structure is ambiguous. Is content structure something different from people's cognitive structures? Is there an external body of knowledge with its own logic and form (Ford & Pugno, 1964; *Education and the structure of knowledge*, 1964), or can we only meaningfully speak of the structure of individual understandings? If the distinction between external and internal structures is sound, what is the relationship between the two? These questions are substantive because instructional-design theory has been challenged in the past because of its behavioristic focus on external tasks and lack of attention to mental structures and the cognitive mediation of learning.

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[1] Wilson and Merrill (1980) argue that both learning hierarchy analysis and ET analysis result in simple-to-complex sequencing. If this is true, then searching for prerequisite relationships in ET-sequenced skills is a largely redundant exercise.

Certainly, a variety of task analyses may be performed that emphasize different aspects of the task, many of which do not attempt to model cognitive structure (Jonassen, Hannum, & Tessmer, 1989). The same may be said of content structures. Content may be categorized, analyzed, and represented in different ways for different purposes, and need not relate directly to internal cognitive representations. While different positions may be taken, however, we believe that content/task analysis, as a basic ID procedure, is most useful when it *models* in external form the structure and process of people's knowledge and skills. Such a model of internal forms is important as a basis for planning sound instruction.[2] Typically, the most useful kind of "content structure" is a model of the way knowledge is thought to be structured in people's minds. Admittedly, an external model may be a poor approximation of people's knowledge, but it serves a useful purpose for planning and designing instruction.

HOW IS CONTENT STRUCTURED?

If we accept the notion of content structure as modeled cognitive structure, the next question becomes, what kinds of knowledge are there, and how are they structured; that is, how are content elements interrelated? Another way of asking the question is, how is human knowledge organized? As we might imagine, there are as many answers to this question as there are models of human thought and memory, ranging from simple chains of learned behaviors to complex networks to a refusal to explicitly model human knowledge on the grounds that it is *inherently* tacit and ineffable.

Anderson (1990) posits two basic kinds of knowledge: declarative and procedural knowledge. This distinction is also made by philosophers (Ryle, 1949) and is influential among educational psychologists (E. Gagne, 1985). The distinction is also popular with instructional designers (e.g., Gagne, Briggs, & Wager, 1988). Practicing teachers and designers make common reference to "knowledge" (declarative knowledge) and "skills" (procedural knowledge). Thus students may learn about computers, or they may learn how to operate them. The two forms of knowledge support each other. Some theorists add image encoding as a separate knowledge type (e.g., Kosslyn, 1980; Gagne, Yekovich, & Yekovich, in press), but instructional designers have not emphasized imagic knowledge as an independent learning outcome.

Several theorists add an integrative structure of some sort to accommodate these knowledge elements into a whole pattern, referred to variously as schema, script, frame, or mental model (Norman, Gentner, & Stevens, 1976; Johnson-Laird, 1982). Rumelhart and Norman (1981) propose that all knowledge is procedurally represented, "but that the system can sometimes interrogate this *knowledge how* to produce *knowledge that*," that is, declarative knowledge (p. 343). Simon (1980) holds a similar view. Tulving's (1985) research suggests at least three types of memory: (1) procedural memory, with a specialized subset of (2) semantic memory, with a specialized subset of (3) episodic memory.

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[2] We are not naive to the controversy surrounding attempts to explicitly model human cognitive structure (e.g., Dreyfus & Dreyfus, 1986; Churchland, 1984). It seems clear that present methodologies are only partially successful at capturing human expertise. We are also sensitive to connectionist models of cognition that emphasize pattern matching over rule-following (Bereiter, 1991; Bechtel, 1991; Martindale, 1991). Nonetheless, modeling of content structure, whatever its limitations, remains a valuable component of the instructional design process.

A number of psychologists have added the situation or context of use as part of what gets learned (Brown, Collins, & Duguid, 1989). Rather than thinking of expertise as the acquisition of a general schema, they claim that learning and expertise are always embedded in a particular physical, social, and cultural context. Learning is a matter of enculturation, that is, of becoming part of a community which jointly constructs meaning. Seen in this way, the context of use becomes part of the "content structure" in need of analysis and representation for the design of instruction.

As mentioned, there is even some resistance to the notion that human expertise can be defined by discrete concepts and rules. Dreyfus and Dreyfus (1986) argue that real knowledge cannot be separated from the person, and that reductionist attempts to model knowledge explicitly are doomed to failure. In a less radical but equally compelling position, Bereiter (1991) challenges the idea common in cognitive science that human thinking is rule-based; instead, he presents an argument for viewing thinking in connectionist terms as a pattern-matching, pattern-using activity.

> At least since Rousseau, there has been a strain of educational thought opposed to the classical, rule-based view of learning and cognition. It has often appealed to biological concepts of growth, emergence, and organicism or to social and cultural concepts and has emphasized imagination, spontaneity, feeling, and the wholistic character or understanding....This strain of thought has given rise to many worthwhile developments in education, such as the...currently popular whole language movement. (Bereiter, 1991, p. 15)

The connectionist model thus rejects the partitioning of knowledge into discrete structures (e.g., declarative and procedural), integrating cognitive, affective, and psychomotor aspects of performance. Bereiter contrasts this wholistic view of learning with a more rule-based approach:

> In contrast to the Rousseauistic tradition is a family of instructional theories in which rules, definitions, logical operations, explicit procedures, and the like are treated as central (Reigeluth, 1983). From a connectionist standpoint, this family of instructional theories has produced an abundance of technology on an illusory psychological foundation. (Bereiter, 1991, p. 15)

Connectionist theorists would clearly object to ET's discretely dividing knowledge into concepts, procedures, and theories. Bereiter concludes the article by suggesting that the "situated" and "embodied" cognitive approaches could provide a comprehensive alternative that would accommodate elements of both rule-based and connectionist perspectives appropriately. ET currently does not provide detailed prescriptions for making instructional sequences "authentic" or "situated" in a context similar to real-life problems.

The claim that not all people solve problems by following rules finds support in research by Papert (1988) and Gilligan (1982). Papert explains the two ways bright 10- and 11-year-olds program computers. One way

> fits the model of "the logical." Faced with a problem, [the children] subdivide it, modularize it, deal with the parts one at a time, put them together and make a program that is clearly logically structured.
>
> But other children demonstrate a different style—one in which a program emerges...through something closer to the way in which a sculptor or painter makes a work of art—a process in which the plan of what is to be made emerges and is refined at the same time as the created object takes form. (p. 12)

Papert says the children who use the "negotiational style are performing at an intellectual level that is fully as excellent and of high quality as the other children" (p. 12).

CONTENT STRUCTURE AS ORGANIZING STRUCTURE

Recall that ET suggests using content structure as an organizing and sequencing device, with three main prescriptions offered. First, courses and lessons should be organized into components according to the content structure being taught. This prescription is fairly broad and benign. The second prescription is stronger: A course's organization should depend on the primary goals of instruction: conceptual, procedural, or theoretical. If you want learners to have a conceptual overview of a new subject, subdivide and organize the course's lessons according to a taxonomy. If your goals are procedural, begin with the simplest version of the procedure and progressively add more steps and decision points; and if your goals are theoretical, begin with the most important principles and add qualifying or extending principles in later lessons. The third prescription is also strong: Course units should all reflect the primary organizing structure. That is, a course with a conceptual structure as its primary organizing structure should be chunked into lessons of concepts within the original conceptual structure. A procedural course should be chunked into increasingly complex versions of the overall procedure. The rationale for the latter two prescriptions seems to be that if the organizing structure entirely reflects the primary course goals it will enhance meaningful encoding, retention and retrieval.

The first prescription—that course organization should basically reflect content structure—is consistent with text design studies of access structure. As a rule, students are aided when text structure somehow reflects underlying semantic structure (see, however, Mannes & Kintsch, 1987, discussed below). The second and third prescriptions, though, are much stronger versions of the idea. Again, such constraints on designer judgment provide ostensive gains in economy but questionable payoff. The rationale for a single organizing structure seems to be based on assumptions that the development of stable cognitive structures, a goal of ET (Reigeluth, 1983), is best achieved by presenting content in the framework of a single, top-down organizing structure. As we will illustrate below, there are many challenges to this assumption.

There seems to be little evidence to draw on in psychology literature to support such a constrained approach to course organization. Posner and Strike (1976; Strike & Posner, 1976) reviewed a variety of methods for organizing courses. In essence, they suggest that a course structure should have a certain "face validity" to the student; that is, it should have a logical and meaningful connection to students' prior understanding. The implication of their review is that courses need some kind of organizing device or logic; the precise kind of organization is much less important than that it make sense to the learner.

Posner and Rudnitsky (1986) present a somewhat eclectic approach to course design. Rather than three basic kinds of course structure, they suggest a variety of orientations: inquiry, application, problem, decision, skill, or personal growth. Laurel (1991) presents a strong case for organizing computer interactions based on a theatre metaphor, involving the learner in a stage-like structure. This longer, looser list seems to leave more room for accommodating different kinds of course and learning goals, as well as prior knowledge; moreover, following Posner and Rudnitsky, a course's orientation does not constrain its sequencing strategy.

We would argue for a revision of ET that relaxes the connection between course goals and overall content structure. First, course goals can be typed on a broader basis than the three goals listed by ET. Second, a variety of chunking strategies may be useful for subdividing lesson elements above and beyond a single type of content structure. Designers need to guard against rigid conceptions of the domain and encourage a more dynamic structure for students to access and learn at various points of instruction.

ILL-STRUCTURED DOMAINS

Another perspective on the structure of knowledge raises additional concerns about ET. Spiro and colleagues (Spiro, Feltovich, Coulson, & Anderson, 1989; Spiro & Jehng, 1990) became frustrated in their attempts to apply ID principles in teaching complex and ill-defined domains. This, according to Spiro, can partly be attributed to the fact that most ID principles are based on research using introductory subject matter. As expertise increases, however, the "content" becomes less easily defined, more conditional and problematic, and much more difficult to capture using traditional representational modes. As a consequence Spiro and colleagues have proposed a dynamic view of knowledge, which they call *cognitive flexibility theory*. According to this theory, in complex and ill-defined domains, a person generally cannot retrieve an intact schema from memory; instead, schemas combine or recombine in response to the requirements of each particular situation. Spiro and colleagues have developed an instructional approach to facilitate knowledge acquisition in complex and ill-defined domains, criss-crossing the domain with mini-cases to provide multiple perspectives which can later be reassembled. They recommend the use of multiple analogies and cases to prevent the development of oversimplifications and misconceptions common among students (Spiro, Feltovich, Coulson, & Anderson, 1989).

A key feature of cognitive flexibility theory is its view of the subject matter. At least for advanced knowledge levels, content structure cannot simply be captured, analyzed, and used to organize courses. Advanced knowledge is variable, dynamic, and ill-defined; students in turn need a variety of perspectives and experiences to appreciate its complexity and subtlety. Students will tend to oversimplify and overgeneralize when presented single analogies or discrete procedures and rules. Moreover, students' misconceptions are fairly robust and resistant to change (Spiro et al., 1989, 1990). This dynamic view of the subject matter seems at odds with ET, which assumes that the designer will organize instruction based on a well-defined content structure.

ET's strong typing of knowledge categories—conceptual, procedural, and theoretical—is one of its most theory-laden prescriptions. Constraints on knowledge representation might be justified if there were some kind of consensual agreement among researchers, yet precisely the opposite is the case. According to one survey of educational literature in language and cognition, twenty-five distinct categories of knowledge were identified (Alexander, Schallert, & Hare, 1991). Philosophers and humanistic theorists have even more widely diverging views about the nature of knowledge and expertise (e.g., Schon, 1987; Dreyfus & Dreyfus, 1986; Winograd & Flores, 1986). This is a far cry from ET's three basic knowledge types! Indeed, the overwhelming finding concerning knowledge representation seems to be that *there is no single right way to represent knowledge*, even for a given context or instructional purpose. Even if a course were thought to be primarily "conceptual" in purpose, a number of diverse outcomes are associated with "conceptual" learning (Tessmer, Wilson, & Driscoll, 1990; Wilson & Tessmer, 1990). ET's use of conceptual, procedural, and theoretical structures achieves parsimony in its procedures, but at a high cost to validity and fidelity to current models of learning and knowledge.

SEQUENCING ISSUES

ET suggests that instruction proceed from highly simplified representations to gradually more complex content. While this prescription is perhaps amenable in well-structured domains, where expertise is clearly defined, it is problematic in ill-structured domains. For example, if the primary content structure is procedural, ET would identify the various paths through a given procedural network, then begin with the simplest version of the procedure; subsequent elaborations would merely add complexity to the basic procedure. But ET does not provide for the possibility, or even desirability, of two learners learning mutually exclusive procedures. Recall that Papert (1988) found that student programmers engage in mutually exclusive styles (logical vs. negotiational). Also, Resnick (1983) has shown that math students construct more sophisticated procedures than those taught in class. Thus an ID that depends entirely on a single representation of structure could possibly limit students' personal constructions of meaning from the content.

A number of theorists support the basic sequencing precepts of ET. Bunderson, Gibbons, Olsen, and Kearsley (1981) suggested that instruction be geared around a series of work models, each progressing in complexity. Learners then "work" and solve problems within a current level of work model until a mastery level of performance is reached; they are graduated to the next level, which builds upon the prior level. This is similar in some ways to White and Frederiksen's (1986) approach that builds instruction around a series of increasingly complex qualitative mental models. However, their approach begins with students' intuitive mental models, forcing students to confront their misconceptions and develop increasingly more sophisticated and correct mental models. White and Frederiksen have applied their simple-to-complex sequencing strategy to the design of intelligent tutoring systems, as well as more traditional computer-based simulations.

MICROWORLD DESIGN

Burton, Brown, and Fischer (1984), anticipating "situated cognition" (see discussion above) used skiing as a basis for studying the design of learning environments which they called "increasingly complex microworlds." Helping novice performers "debug" their skills is a key goal of microworlds: "The appropriate microworld can transform 'nonconstructive bugs' into 'constructive bugs,' ones that can be readily learned from" (Burton, Brown, & Fischer, 1984, p. 140).

Burton and colleagues point to three primary design variables of skill-based microworlds:

1. equipment and tools used in performing the skill;
2. the physical setting in which the skill is performed;
3. the specifications for correctly performing the task.

The authors' notion of microworld design shares one key design feature with ET, that of performing the simplified whole task whenever possible:

> Within each microworld that a beginning skier goes through, a particular aspect of the skill is focused on. But this skill is not executed in isolation. The student must still do simplified versions of many other skills required to ski. Simplifications of other interacting subskills let the student learn not only the particular subskill but also how it is used in the context of the entire skill. (p. 150).

However, they differ from ET in their emphasis on the means of simplification. Burton and colleagues encourage simplifications of all three design variables, but within real-world contexts. They simplify equipment by recommending the use of short skis rather than long ones. They recommend simplifying the physical setting by finding a downhill slope that feeds into an uphill slope so the learner can learn to glide without having to learn at the same time to stop. They also simplify the task itself by asking the novice to practice gliding rather than traversing. Thus a variety of means of task simplification are available that go beyond what we normally think of as content structure (see also Wilson, 1985).

FUNCTIONAL CONTEXT TRAINING

Montague (1988) provides evidence for the effectiveness of "functional context training," a spiraling method which begins with familiar objects about which learners have intuitive knowledge and moves to progressively more complicated but still familiar objects. For example, an introductory course for electronic technicians uses concrete and familiar objects for instruction, starting with a flashlight and proceeding to a table lamp, a curling iron, an AC adaptor, and a soldering iron. Instruction is situated in realistic settings; it integrates several domains of knowledge at once: problem solving, basic electricity/electronics knowledge, mental models of devices, language processing, and mathematics. The sequencing emphasis for the functional context approach is to move from simple-familiar toward more complex-familiar. This is similar to ET. The approach differs from ET in its emphasis on fidelity to job conditions and in-context training. Also, rather than elaborating upon a single epitome, they use a series of concrete cases or analogies, each drawing attention to different aspects of the subject area.

COGNITIVE APPRENTICESHIPS

Collins, Brown, and Newman (1989) have described their idea of the "cognitive apprenticeship." Like Montague (1988), they provide numerous recommendations for integrating instruction with realistic performance. Their specific recommendations for sequencing content, however, are similar to those of ET in many ways: (1) increasing complexity, (2) increasing diversity, and (3) global before local skills. The third recommendation requires a short explanation. Collins et al. suggest scaffolding as a way to support lower-level skills while the student thinks about larger problems. "In algebra, for example, students may be relieved of having to carry out low-level computations in which they lack skill to concentrate on the higher-order reasoning and strategies required to solve an interesting problem....The chief effect of this sequencing principle," they explain, "is to allow students to build a conceptual map, so to speak, before attending to the details of the terrain" (p. 485). This idea of supporting performance and helping students develop clear mental models is implicit in ET and certainly consistent with its principles (*cf.* Wilson, 1985, 1985–86).

Collins cites Schoenfeld's (1985) math research as a cognitive apprenticeship. He has developed an approach for teaching college-level math that employs a number of innovative instructional strategies. The method focuses on guiding students to use their current knowledge to approach and solve novel problems. The instructor models problem-solving heuristics, including the inevitable false starts and dead ends; the process of math problem solving is shown to require creativity and flexibility. It is noteworthy that Schoenfeld sequences lesson plans around carefully selected cases that build on each other in a simple-to-complex fashion. These cases are selected to bring out certain features to be learned; class discussions and problem-solving activities are flexible within the overall structure of the ordered cases.

CASCADED PROBLEM SETS

Schank and Jona (1991) present a sequencing approach they call *cascaded problem sets*, one of several possible teaching architectures they recommend, including case-based learning, incidental learning, simulation, and directed exploration. Cascaded problem sets rely on many assumptions similar to those of ET; however, instead of beginning with the simplest case, Schank *begins at the end and then works backward*. In essence, Schank is saying, "We don't presume to know just what a beginning student already knows; we prefer to give an overall picture of the final task by starting at the end, then work backwards to find a realistic starting place depending on the student's initial competency level."

> The idea is to build a problem space whereby each problem relates to each other problem with respect to the extra layer of complexity that it entails. In other words, "if you can't solve Problem A, you certainly can't solve Problem B" means that B is logically above A. Between A and B would be some information that B entails that A does not. Below A would be something simpler than A that perhaps does not entail the knowledge common to A and B. As students have trouble with one problem, they move *down* the cascade of problems by learning about the issues that one would need to know to solve the problem they were having trouble with. (Schank & Jona, 1991, pp. 20–21, italics added.)

Another difference with ET is that Schank considers task components as part of the cascaded problem set. "A problem must be broken down into its constituent parts. Each constituent would itself be a problem, and it too would have constituent parts....For example, at the bottom of a cascade of algebra problems would be basic arithmetic" (Schank & Jona, 1991, p. 20). This parts analysis seems more reminiscent of Gagne's learning hierarchies than ET's meaningful spiraling. In either case, the idea of cascaded problem sets is clearly derivative of well-established ID principles, including work on computer-adaptive testing, even though the authors do not cite previous work on the problem.

MIDDLE-OUT SEQUENCING

ET's conceptual structures are sequenced from the top down, that is, from the most general conceptual category down to the most detailed sub-category in a taxonomy. We have criticized this approach elsewhere (Wilson & Cole, in press a) for its failure to accommodate learners' prior knowledge. Our basic point is, why teach the concept 'vertebrate' before 'cow' to a small child, just because it happens to be higher in a conceptual hierarchy? Lakoff (1987) makes a similar point; he reviews a large body of literature suggesting that in normal settings, people tend to classify and think about objects at a "middle level," not too general and not too detailed. Rosch (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976) gives the term 'basic categories' to this level of natural perception. For example, people tend to think in terms of dogs (basic level) rather than animals (superordinate level) or retrievers (subordinate level). Similarly, 'chair' is more psychologically basic than 'furniture' or 'rocker.' Rosch suggests that most of our knowledge about the world is organized at this level; most attributes pertaining to category membership are stored at this middle level. She also suggests that this basic level of category is:

- The highest level at which category members have similarly perceived overall shapes.
- The highest level at which a single mental image can reflect the entire category.
- The highest level at which a person uses similar motor actions for interacting with category members.
- The level at which subjects are fastest at identifying category members.
- The level with the most commonly used labels for category members.

- The first level named and understood by children. (Lakoff, 1987, p. 46)

If people organize their knowledge primarily around these basic-level categories, then it seems unreasonable to insist on proceeding in a strict general-to-detailed order down a taxonomy. A more defensible strategy would start from learners' prior schemas, then proceed both up and down the taxonomy into new territory, as increasingly difficult but authentic tasks require. Tessmer (1991) terms this a "middle-out" sequencing strategy, where instruction begins at a middle level of generality, gradually adding both superordinate and subordinate detail. This alternative sequencing strategy represents a significant revision of ET's design prescriptions.

SEQUENCING FOR CONCEPTUAL CHANGE

A line of cognitive research investigates instructional interventions that try to link up with learners' preconceptions and schemas about the world (e.g., Siegler, 1991); this body of research is sometimes referred to as conceptual change literature. Some researchers (e.g., Case & Bereiter, 1984; Resnick, 1983; White & Frederiksen, 1986) have directly challenged models that order instruction based on subject matter logic and neglect learners' existing conceptions. Preexisting conceptions may be a help or a hindrance to new learning; misconceptions and "buggy" procedures can often interfere with the assimilation of new skills and knowledge. Case (1978) developed an instructional model in which the teacher directly confronts learners' misconceptions; after learners see clearly the inadequacy of their existing conceptions, they become ready to acquire new models, and will tend to integrate the new knowledge more directly into their current structures. The general strategy for conceptual change is :

1. Learners must become dissatisfied with their existing conceptions.
2. Learners must achieve at least a minimal understanding of an alternate way of conceptualizing the issue.
3. The alternative view must appear plausible.
4. Learners must see how the new conceptualization is useful for understanding a variety of situations. (based on Bransford & Vye, 1989)

Whereas an ET-style lesson might proceed smoothly through a content structure, conceptual-change lessons proceed in fits and starts, working from student misconceptions, failing, trying again, beginning false starts, retreating from dead ends, each time elaborating upon students' schematic understandings (*cf.* also Schoenfeld, 1985). The "elaboration" is not on an external content structure, but rather on an internal representation.

Thus the conceptual change literature emphasizes the dynamic nature of learning. Two observations are particularly relevant here. First, learners' understandings result from the interplay of their prior/existing knowledge and the current instructional situation (e.g., Mayer, 1980). Second, we cannot anticipate students' emergent mental models; they may be riddled with "bugs" or more sophisticated than a course's terminal objective (e.g., Resnick, 1983). ID must accommodate this dynamic, often chaotic situation (e.g., Jonassen, 1990; Winn, 1990).

A number of conceptual-change researchers draw heavily on Vygotsky's notion of a "zone of proximal development," wherein children can perform tasks with the help of adult "scaffolding" and assistance (Wertsch, 1985). Vygotsky's approach would sequence tasks so as to keep learners engaged in tasks that stretch them to go beyond their present level of expertise, but which can be performed with social support and appropriate tools and information resources.

In line with Vygotsky's zone of proximal development, Newman, Griffin, and Cole (1989) think of tasks as something accomplished by groups of people. They contrast their approach with traditional ID. Following traditional ID,

> First, the tasks are ordered from simple or easy to complex or difficult. Second, early tasks make use of skills that are components of later tasks. Third, the learner typically masters each task before moving onto the next. This conception has little to say about teacher-child interaction since its premise is that tasks can be sufficiently broken down into component parts that any single step in the sequence can be achieved with a minimum of instruction. Teacherless computerized classrooms running "skill and drill" programs are coherent with this conception of change. (Newman, Griffin, & Cole, 1989, p. 153)

The authors contrast this task-analysis approach with a more teacher-based approach where simplicity is achieved by the social negotiation between teacher and learner:

> The teacher and child start out doing the task together. At first, the teacher is doing most of the task and the child is playing some minor role. Gradually, the child is able to do more and more until finally he can do the task on his own. The teacher's actions in these supportive interactions have often been called "scaffolding,"...suggesting a temporary support that is removed when no longer necessary....There is a sequence involved...but it is a sequence of different divisions of labor. The task—in the sense of the whole task as negotiated between the teacher and child—remains the same. (p. 153)

This sequencing method is less analytic and formal than ET, yet the end product of the social interaction is usually a simple-to-complex sequencing of "content." This approach, like the skiing example above, offers a more flexible view of content and ways of simplifying instruction.

INTERNAL REFLECTION-IN-ACTION PROCESSES

Schon's (1983, 1987) reflective practitioner model sees professionals—doctors, lawyers, architects, teachers, etc.—as embodying personal theories of practice. These personal theories are much more important than academic theories or representations of expertise. When professionals (or aspiring professionals) encounter a problem in everyday work, much of their response is routinized, but there is nonetheless an element of on-the-spot reflection and experimentation. Schon describes a typical learning sequence of reflection-in-action:

- First we bring routinized responses to situations. These responses are based on tacit knowledge and are "spontaneously delivered without conscious deliberation." The routines work as long as the situation fits within the normal range of familiar problems.
- At some point, the routine response results in a *surprise*—an unexpected outcome, positive or negative, that draws our attention.
- The surprise leads to reflection-in-action. We tacitly ask ourselves "What's going on here?" and "What was I thinking that led up to this?"
- Through immediate reflection, we re-examine assumptions or recast the problem in another way. We may quickly evaluate two or three new ways to frame the problem.
- We engage in an "on-the-spot experiment." We try out a new perspective or understanding of the situation, and carefully note its effects. The cycle of routine performance—surprise—interpretation—experiment is repeated as needed. (adapted from Schon, 1987, p. 28)

Schon rejects the validity of traditional academic formulations of expertise. The traditional discipline—its theories, concepts, models, etc.—simply does not capture the personal expertise needed to reason and evaluate in a professional capacity. By extension, we could argue that instructional designers simply cannot capture, represent, and teach the "content structure" really needed for expertise. That expertise lies embedded within the expert practitioner, and can only be acquired through extended opportunities of practice in authentic settings, with appropriate coaching, mentoring, and other guidance with feedback. The guidance is less in the form of general principles and rules, and more in the form of contextualized reasoning based on the specifics of a case. Because the domain is ill-structured, the practitioner cannot always routinely activate an intact schema; instead the practitioner must assemble a new schema, combining and recombining knowledge from many cases in memory.

Viewed differently, the reflective-practitioner model provides a convincing portrait of the way that general models of ID relate to the everyday practice of ID professionals. There is a growing indication that instructional designers do not apply formal models in a lock-step fashion. Indeed, ID models often fail to capture expert designers' knowledge and skill. This common problem between theory and practice is aggravated when the "prescriptive" ID models are represented in a highly technical and rigidly proceduralized fashion. We return to this point in the recommendation section below.

Putnum (1991) reports some interesting research in which he observed how consultants grew in their expertise in using Schon's reflective practitioner model with teachers. Putnum notes:

> Many of us who seek to engage people in significant learning experiences disparage formulas, rules, or recipes for action as superficial....Novices are likely to misuse rules and recipes; they have not developed the know-how to use them correctly.
>
> Yet well-intentioned learners do search for rules and recipes, especially early in a learning process. As one participant said after a workshop on promoting organizational learning, "If you could only give us a list of the eight things to say, that would be really helpful in getting started." This person was not naive; he understood that a handful of recipes was not a substitute for genuine mastery. The difficulty is that a new theory of practice cannot be acquired whole. Yet if it is acquired piecemeal, the pieces are likely to be used in ways that violate the whole. (p. 145)

Schon's model includes several techniques that Putnum calls "recipes." In a general sense, "a recipe is a formula, a set of instructions, for designing action" (Putnum, 1991, p. 147). In his research, Putnum studied a particular kind of recipe, a question fragment ("What prevents you from...?") used as a technique in consulting situations. Putnum reports that consultants seemed to progress through stages of competence in their use of these fragments:

1. Novices use recipes as "one-liners" or invariant procedures. "Lacking experience in the theory of practice from which the recipe was drawn, novices may get themselves in trouble they cannot get themselves out of. Nevertheless, they may feel a sense of success at having done what they are 'supposed to do,' what they believe an expert might have done. At the same time they may feel some discomfort or chagrin at imitating or 'being a parrot'" (Putnum, 1991, p. 160).
2. The novice gradually shifts orientation from the recipe itself to broader strategies and concepts. Still, "learners may remain caught in a kind of tunnel vision, concentrating intently on the mechanics of implementing the new strategy. It is therefore difficult to respond flexibly to the [dynamic feedback] of the situation" (p. 160).
3. Eventually, learners become able to "respond to surprising data by reframing the situation, stepping out of their original perspective to take account of another." Learners' attitudes about recipe-following also shift: "Rather than

> feeling successful simply by using a recipe, they may consider whether that usage was pro forma or genuine" (p. 161).

Putnum points to three positive functions of recipes that serve to counterbalance the negative effects of their misuse by novices. First, they serve to elicit useful data in practice situations. That data can then serve as feedback to learners in improving their practice. Second, recipes tend to have memorable phrases which can serve as hooks or mnemonics to aid performance. Thus a recipe may act as a retrieval cue to activate an appropriate schema for a given situation. Third, the concrete, memorable nature of recipes also can aid problem encoding and reflection. Students often organize their reflective thoughts around preexisting recipes.

The reflective practitioner model is relevant to ET because it highlights how learners themselves construct and organize meaning in a basically simple-to-complex way. Novices take what they can from the content. Then, given authentic performance opportunities and appropriate coaching and reflection, surface-level imitation proceeds to a kind of problem solving based on deeper understanding of the situation. As Resnick (1983) stated, "Effective instruction must aim to place learners in situations where the constructions that they naturally and inevitably make as they make sense of their worlds are *correct* as well as sensible ones" (p. 31). Rather than being "presented" the content structure, learners construct the content for themselves through reflective processes. Thus a simple-to-complex progression may occur, even if the external "content" remains the same: the same recipe comes to mean something entirely different to an experienced practitioner.

MAKING CONTENT STRUCTURE EXPLICIT

ET suggests that content structure be made explicit to students through various synthesizers and organizers. This approach is in line with most research on text design (e.g., Jonassen, 1982, 1985). However, findings of Mannes and Kintsch (1987) and McDonald (1988), challenge the conventional wisdom about organizing devices and synthesizers. They found that presenting students an outline consistent with the text structure fostered memory-level encoding but impeded far transfer of the material to problem-solving tasks. This finding may be related to Smith and Wedman's (1988) comparison between instruction sequenced according to ET prescriptions and Gagne-style learning hierarchies. They found that students made more meaningful elaboration upon the learning hierarchy sequenced material, even though the ET materials were more meaningfully ordered and presented. It seems possible that highly structured and clearly ordered materials may allow superficial encoding precisely because of their easy access structure.

These possible negative effects of explicit teaching of structure may be related to the reported negative effects of constant knowledge-of-results feedback for motor learning tasks (Salmoni, Schmidt, & Walter, 1984): When the student has to do less work to make sense of things, less learning may occur. Salmoni et al. distinguish between immediate performance in instruction and delayed performance as a measure of learning. They suggest that certain instructional strategies may result in a performance decrement during practice, but that on a retention task, the strategies may result in learning gains. Thus the possibility may be entertained that ordering instruction in a too facile way could result in minimal dissonance and could ironically result in shallow processing of material by students (Wilson & Cole, 1991 b). Salomon and Sieber (1970) provide some evidence for this interpretation. They hypothesized "(a) that a randomly spliced film arouses states of uncertainty which in turn lead the learner to extract information concerning possible interpretations of [the] film, and (b) when the film is well organized, it provides a structure for remembering details" (Salomon, 1974, p. 394). This is an area that is threatening to key concepts in ID; there is an obvious need, however, for further research before strong claims can be supported.

Constructivism has recently gained prominence as a philosophy of cognitivism; ID theorists currently are exploring implications for practice (e.g., *Educational Technology*, May and September 1991). A constructivistic approach to instruction is reflected in Harel and Papert's (1990) teaching of fractions through Logo. Students' learning of fractions was reinforced by their designing computer lessons which taught something about fractions. Through the process of designing the lessons, students came to understand the procedures and concepts of fractions at a deeper level than a control group. Their knowledge of Logo programming, fractions, and problem-solving skills significantly exceeded those of both a Logo-programming group and a control group. (The design group, however, took proportionately longer on task.) The fractions study reflects a growing emphasis among cognitive researchers in design and composition activities as a method of learning new knowledge (Harel, 1991). An analogy might be the student journalist who learns a lot about both street crime and writing by doing a series of stories on the subject. Currently, ET does not directly address the issue of building instruction around design activities.

Constructivistic/connectionistic approaches also tend to stress coaching environments (Burton & Brown, 1979; Rossett, 1991) and inquiry-learning strategies (McDaniel & Schlager, 1990; Collins & Steven, 1983). The conditions of appropriate use of a variety of alternative sequencing strategies go beyond ET prescriptions and need to be more clearly articulated for instructional designers to be able to make appropriate design decisions.

RECOMMENDATIONS

As research in cognitive psychology continues to shed light on the process of learning, we are forced to reexamine the assumptions and prescriptions of various theories of ID, including ET. We have explained what we believe are some of the stronger challenges to ET. Following are some of the clear implications for change, which we believe may require a radical restructuring of ET, particularly if it is to serve the needs of instruction in complex and ill-defined domains:

1. *Deproceduralize the theory*. In its current form, ET is less a theory and more of a design procedure. Explicit steps are provided for designing and sequencing instruction. This procedural approach has two problems associated with it: (a) the procedural prescriptions often go far beyond our knowledge base about learning and instructional processes, and are often at odds with that knowledge; and (b) instructional designers tend to follow models in a principle-based, heuristic manner in spite of detailed procedural specifications (Taylor, 1991; Wedman & Tessmer, 1990; Nelson & Orey, 1991; Schon, 1983). ET should be reformulated into a set of guiding principles referenced more clearly to learning processes. A principle-based formulation will allow practicing designers to adapt the concepts to a greater variety of instructional situations.

   The key principles of a revised version of ET seem to be:

   - All subject matters have an underlying content structure, i.e., how people relate constructs together meaningfully. This structure, however, is personally idiosyncratic and dynamic, particularly in complex domains.

   - The modeled structure of the content should be taken into account in organizing and sequencing courses and lessons. Overall sequence should generally proceed from simple to complex, allowing for the great variety of ways to move toward increasing complexity.
   - The content structure should ultimately be made explicit to the student. The specific mechanisms (e.g., direct instruction versus inquiry methods) should be determined by the instructional situation (learner characteristics, goals, setting, need for efficiency, etc.).

2. *Remove unnecessary design constraints.* A number of ET prescriptions constrain designer options without a demonstrable return in the form of instructional effectiveness. Examples include
   - the use of three primary structures (conceptual, procedural, and theoretical),
   - tying together the primary course goal and primary organizing structure, and
   - using a single structure as a basis for organizing the entire course.

   These prescriptions make ET's application more standardized and parsimonious, but they also preclude a number of alternative organization schemes that follow the "spirit" of ET but not the "letter." Again, a principle-based formulation of ET could more easily accommodate variant schemes.
3. *Base organization and sequencing decisions on learners' understandings* as well as the logic of the subject matter. An assumption implicit in ET is that the simplest, most general concepts in a subject are also the closest to learners' prior understanding. We have shown this assumption to be unfounded. An alternative emphasis would be to add these heuristics:
   - Move from familiar to less familiar content.
   - Use content with high interest and perceived relevance (Hidi, 1990).
   - Create and then take advantage of the "teaching moment" (Bransford & Vye, 1989) when learners are receptive and prepared for new ways of looking at things. Induce cognitive conflict, e.g., by presenting an anomaly (Perkins, 1991), then help learners accommodate new information into their existing schemas.
   - Respond to emergent mental models, encouraging learners to confront their misconceptions.
   - Wherever possible, ground instruction in an authentic performance setting. Make heavy use of immediate, concrete situations, tools, problems, and forms of feedback.
4. *Assume a more constructivist stance* toward "content structure" and sequencing strategy. An objectivistic view of content is that it is "out there"; a constructivist view claims that content is in people's minds, generated through a process of social negotiation, and can only be loosely modeled externally (Cunningham, 1991). We can only hope to approximate an accurate representation of true expertise; much of an expert's knowledge is tacit and ineffable, resistant to reduction and analysis. On this view, a desig-ner's understanding of the content can guide selection of learning experiences, but cannot directly control learning outcomes in a direct, engineered way.

AUTHOR NOTES

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REFERENCES

Alexander, P. A., Schallert, D. L., & Hare, V. C. (1991). Coming to terms: How researchers in learning and literacy talk about knowledge. *Review of Educational Research, 61 (3), 315–343.*

Ausburn, L. J., & Ausburn, F. B. (1978). Cognitive styles: Some information and implications for instructional design. *ECTJ, 26* (4), 337-354.

Bechtel, W. (1991). *Connectionism and the mind: An introduction to parallel processing*. Oxford: AIDC/Basil Blackwell.

Bereiter, C. (1991, April). Implications of connectionism for thinking about rules. *Educational* Researcher, 20 (3)10–16.

Bransford, J. D., & Vye, N. J. (1989). A perspective on cognitive research and its implications for instruction. In L. B. Resnick & L. E. Klopfer (Eds.), *Toward the thinking curriculum: Current cognitive research* (pp. 173–205). Alexandria VA: Association for Supervision and Curriculum Development.

Brown, J. S., Collins, A., & Duguid, P. (1989, January–February). Situated cognition and the culture of learning. *Educational Researcher*, 32–42.

Bruner, J. S. (1966). Toward a theory of instruction. Cambridge MA: The Belnap Press of Harvard University Press.

Bunderson, C. V., Gibbons, A. S., Olsen, J. B., & Kearsley, G. P. (1981). Work models: Beyond instructional objectives. *Instructional Science, 10, 205–215.*

Burton, R. R., & Brown, J. S. (1979). An investigation of computer coaching for in formal learning activities. *International Journal of Man-Machine Studies*, 11, 5–24.

Burton, R. R., Brown, J. S., & Fischer, G. (1984). Skiing as a model of instruction. In B. Rogoff & J. Lave (Eds.), Everyday cognition: Its development in social context (pp. 139-150). Cambridge MA: Harvard University Press.

Case, R., & Bereiter, C. (1984). From behaviourism to cognitive behaviourism to cognitive development: Steps in the evolution of instructional design. *Instructional Science, 13,* 141–158.

Case, R. (1978). A developmentally based theory and technology of instruction. Review of *Educational Research, 48, 439–463.*

Churchland, P. M. (1984). *Matter and consciousness: A contemporary introduction to the philosophy of mind.* Cambridge MA: MIT Press/Bradford Books.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale NJ: Erlbaum.

Collins, A., & Stevens, A. L. (1983). A cognitive theory of inquiry teaching. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 247–278). Hillsdale NJ: Erlbaum.

Cunningham, D. J. (1991, May). Assessing constructions and constructing assessments: A dialogue. *Educational Technology*, 13–17.

Dreyfus, H. L., & Dreyfus, S. E. (1986). *Mind over machine: The power of human intuition and expertise in the era of the computer*. New York: The Free Press.

Education and the structure of knowledge. (1964). Fifth annual Phi Delta Kappa Symposium. Chicago: Rand McNally.

Ford, G. W., & Pugno, L. (Eds.). (1964). *The structure of knowledge and the curriculum*. Chicago: Rand McNally.

Gagne, E. (1985). *The cognitive psychology of school learning*. Chicago: Scott Foresman.

Gagne, E., D., Yekovich, C. W., & Yekovich, F. R. (in press). *The cognitive psychology of school learning* (2nd ed.). New York: Harper Collins.

Gagne, R. M., Briggs, L. J., & Wager, W. W. (1988). Principles of instructional design (3rd ed.). New York: Holt, Rinehart and Winston.

Gillian, C. (1982). *In a different voice: Psychological theory and women's development*. Cambridge MA: Harvard University Press.

Harel, I. (1991, April). *When mathematical ideas, programming knowledge, instructional design, and playful learning are intertwined:* The Instructional Software Design Project. Paper presented at the meeting of the American Educational Research Association, Chicago.

Harel, I, & Papert, S. (1990). Software design as a learning environment. Interactive Learning *Environments*, 1(1), 1–32.

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. *Review of Educational Research, 60* (4), 549–571.
Johnson-Laird, P. N. (1982). *Mental models.* Cambridge MA: Harvard University Press.
Jonassen, D. H. (Ed.). (1982). *The technology of text: Principles for structuring, designing, and displaying text.* Englewood Cliffs NJ: Educational Technology Publications.
Jonassen, D. H. (Ed.). (1985). *The technology of text volume two: Principles for structuring, designing, and displaying text.* Englewood Cliffs NJ: Educational Technology Publications.
Jonassen, D. H. (1990, February). Chaos in instructional design. *Educational Technology, 30* (2) 32-34.
Jonassen, D. H., Hannum, W. H., & Tessmer, M. (1989). *Handbook of task analysis procedures.* New York: Praeger.
Kosslyn, S. M. (1980). *Image and mind.* Cambridge MA: Harvard University Press.
Lakoff, G. (1987). *Women, fire, and dangerous things.* Chicago: University of Chicago Press.
Laurel, B. (1991). *Computers as theatre.* Reading MA: Addison-Wesley.
Mannes, S. M., & Kintsch, W. (1987). Knowledge organization and text organization. *Cognition and Instruction, 4,* 91–115.
Martindale, C. (1991). *Cognitive psychology: A neural-network approach.* Pacific Grove CA: Brooks/Cole.
Mayer, R. E. (1980). Elaboration techniques that increase the meaningfulness of technical text: An experimental test of the learning strategy hypothesis. *Journal of Educational Psychology, 72* (6), 770-784.
McDonald, D. (1988). *Drawing inferences from expository text.* Unpublished doctoral dissertation, New Mexico State University, Las Cruces.
McDaniel, M. A., & Schlager, M. S. (1990). Discovery learning and transfer of problem-solving skills. *Cognition and Instruction,* 7(2), 129–159.
Merrill, M. D., Kowallis, T., & Wilson, B. G. (1981). Instructional design in transition. In F. Farley & N. Gordon (Eds.), *Psychology and education: The state of the union.* Chicago: McCutcheon.
Montague, W. E. (1988). Promoting cognitive processing and learning by designing the learning environment. In D. Jonassen (Ed.) *Instructional designs for microcomputer courseware* (pp. 125-149). Hillsdale NJ: Erlbaum.
Nelson, W., A., & Orey, M. A. (1991, April). *Reconceptualizing the instructional design process: Lessons learned from cognitive science.* Paper presented at the annual meeting of the American Educational Research Association, Chicago.
Newman, D., Griffin, P., & Cole, M. (1989). *The construction zone: Working for cognitive change in school.* Cambridge: Cambridge University Press.
Norman, D., Gentner, D., & Stevens, A. (1976). Comments on learning schemata and memory representation. In D. Klahr (Ed.), *Cognition and instruction* (pp. 177-196). Hillsdale NJ: Erlbaum.
Papert, S. (1988). The conservation of Piaget: The computer as grist to the constructivist mill. In G. Forman, & P. B. Pufall (Eds.), *Constructivism in the computer age* (pp. 3-13). Hillsdale NJ: Erlbaum.
Perkins, D. A. (1991, September). What constructivism demands of the learner. *Educational Technology,* 19–21.
Posner, G. J., & Strike, K. A. (1976). A categorization scheme for principles of sequencing content. *Review of Educational Research,* 46, 665–690.
Putnum, R. W. (1991). Recipes and reflective learning: "What would prevent you from saying it that way?" In D. A. Schon (Ed.), *The reflective turn: Case studies in and on reflective practice* (pp. 145–163). New York: Teacher College Press.
Reigeluth, C. M. (Ed.). (1983). *Instructional-design theories and models: An overview of their current status.* Hillsdale NJ: Erlbaum.
Reigeluth, C. M. (1987). Lesson blueprints based on the elaboration theory of instruction. In C. M. Reigeluth (Ed.), *Instructional theories in action: Lessons illustrating selected theories and models* (pp. 245–288). Hillsdale NJ: Erlbaum.
Reigeluth, C. M., & Darwazeh, A. N. (1982). The elaboration theory's procedure for designing instruction: A conceptual approach. *Journal of Instructional Development, 5,* 22–32.
Reigeluth, C. M., Merrill, M. D., & Wilson, B. G. (1979). *The structural strategy diagnostics profile project: Final report.* Provo, UT: David O. McKay Institute, Brigham Young University.

Reigeluth, C. M., Merrill, M. D., Wilson, B. G., & Spiller, R. T. (1978, July). *Final report on the structural strategy diagnostic profile project.* A final report submitted to the Navy Personnel Research and Development Center, San Diego.

Reigeluth, C. M., & Rodgers, C. A. (1980). The elaboration theory of instruction: Prescriptions for task analysis and design. *NSPI Journal, 19,* 16–26.

Reigeluth, C. M., & Stein, R. (1983). Elaboration theory. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status.* Hillsdale NJ: Erlbaum.

Resnick, L. B. (1983). Toward a cognitive theory of instruction. In S. G. Paris, G. M. Olson, & H. W. Stevenson (Eds.), *Learning and motivation in the classroom* (pp. 5-38). Hillsdale NJ: Erlbaum.

Rickards, J. P. (1978). Instructional psychology: From a behavioristic to a cognitive orientation. *Improving Human Performance Quarterly, 7* (4) 256–266.

Rosch, E., Mervis, C., Gray, W., Johnson, D., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8,* 382–349.

Rossett (1991, February). *Coaching successful performance.* Paper presented at the meeting of the Association for Educational Communications and Technology, Orlando.

Rumelhart, D. E., & Norman, D. A. (1981). Analogical processes in learning. In J. R. Anderson (Ed.), *Cognitive skills and their acquisition* (pp. 335-359). Hillsdale N.J.: Lawrence Erlbaum Associates.

Salomon, G. (1974). What is learned and how it is taught: The interaction between media, message, task and learner. In D. R. Olson (Ed.), *Media and symbols: The forms of expression, communication, and education* (*73rd Yearbook of NSSE*) (pp. 383 - 406). Chicago: University of Chicago Press.

Salomon, G. Perkins, D. N., & Globerson, T. (1991). Partners in cognition: Extending human intelligence with intelligent technologies. *Educational Researcher, 20* (3), 2-9.

Salomon G., & Sieber, J. E. (1970). Relevant subjective response uncertainty as a function of stimulus-task interaction. *American Educational Research Journal*, 7, 337-350.

Salmoni, A. W., Schmidt, R. A., & Walter, C. B. (1984). Knowledge of results and motor learning: A review and critical reappraisal. *Psychological Bulletin, 95*(3), 355–386.

Schank, R. C., & Jona, M. Y. (1991). Empowering the student: New perspectives on the design of teaching systems. *The Journal of the Learning Sciences, 1*(1), 7–35.

Schoenfeld, A. H. (1985). *Mathematical problem solving.* New York: Academic Press.

Schon, D. (1983). *The reflective practitioner.* New York: Basic Books.

Schon, D. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* San Francisco: Jossey-Bass.

Siegler, R. S. (1991). *Children's thinking* (2nd ed.). Englewood Cliffs NJ: Prentice-Hall.

Simon, H. (1980). Problem solving and education. In D. T. Tuma & F. Reif (Eds.), *Problem solving and education: Issues in teaching and research* (pp. 81–96). Hillsdale NJ: Erlbaum.

Smith, P. L., & Wedman, J. F. (1988). The effects of organization of instruction on cognitive processing. In M. Simonson (Ed.), *Selected research papers.* Washington D. C.: Association for Educational Communications and Technology.

Spiro, R. J., Feltovich, P. J., Coulson, R. L., & Anderson, D. K. (1989). Multiple analogies for complex concepts: antidotes for analogy-induced misconception in advanced knowledge acquisition. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 498-531). Cambridge UK: Cambridge University Press.

Spiro, R. J., & Jehng, J-C. (1990). Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R. J. Spiro (Eds.), *Cognition, education, and multimedia: Exploring ideas in high technology* (pp. 163-205). Hillsdale NJ: Erlbaum.

Strike, K. A., & Posner, G. J. (1976). Epistemological perspectives on conceptions of curriculums organization and learning. *Review of Research in Education, 4,* 106–141.

Taylor, R. (1991, Spring). NSPI president challenges instructional design profs. *ITED Newsletter*, 1, 4–5.

Tessmer, M. (1991, April). Personal communication.

Tulving, E. (1985). How many memory systems are there? *American Psychologist, 40*(4), 385 - 398.

Wedman, J. F., & Smith, P. L. (1989). An examination of two approaches to organizing instruction. *International Journal of Instructional Media, 16*(4).

Wedman, J., & Tessmer, M. (1990). Adapting instructional design to project circumstance: The layers of necessity model. *Educational Technology*, 48–52.

Wertsch, J. V. (1985). *Vygotsky and the social formation of mind*. Cambridge MA: Harvard University Press.

White, B. Y., & Frederiksen, J. R. (1986). *Progressions of quantitative models as a foundation for intelligent learning environments. Technical Report # 6277*, BBN.

Wilson, B. G. (1985). Techniques for teaching procedures. *Journal of Instructional Development*, *8* (2) 42 - 51.

Wilson, B. G. (1985–86). Using content structure for course design. *Journal of Educational Technology Systems*, *14* (2), 137–147.

Wilson, B. G., & Cole, P. (in press a). An instructional-design review of cognitive teaching models emerging from cognitive psychology. *Educational Technology Research & Development Journal*.

Wilson, B., & Cole, P. (in press b). Cognitive dissonance as an instructional variable. *Ohio Media Spectrum*.

Wilson, B. G., & Merrill, M. D. (1980). General-to-detailed sequencing of concepts in a taxonomy is in general agreement with learning hierarchy analysis. *Performance and Instruction*, 1980, *19*, 11 - 14.

Wilson, B. G., & Tessmer, M. (1990). Adults' perceptions of concept learning outcomes: An initial study and discussion. In M. Simonson (Ed.), *Proceedings of selected research presentations*. Washington, D. C.: Association for Educational Communications and Technology, Research and Theory Division.

Winn, W. (1990). Some implications of cognitive theory for instructional design. *Instructional Science*, 19, 53-69.

Winograd, T., & Flores, F. (1986). *Understanding computers and cognition: A new foundation for design*. Norwood NJ: Ablex.

Title:

Experienced and Novice Teacher Differences in Identifying Instructional Problems

Author:

Beverly A. Wolf

Abstract

Teachers average one decision every two minutes while they are teaching. The kinds of decisions they make affect their students. One hundred twenty-two undergraduate and graduate education majors were tested to explore what decisions they would make when confronted with problem statements referring to the planning and delivery of instruction. Results indicated that experienced teachers were better able to identify problem situations and choose the appropriate missing component than novice teachers. Instructional design principles can help teachers recognize problems and make appropriate changes in their instruction.

Introduction

It has been proposed that if instructional design (ID) principles were incorporated into the classrooms by teachers, "students would become motivated, instruction would become clear and logical, student achievement would increase, teachers would be freed from the drudgery of routine tasks, and classroom activities would become more varied" (Kerr, 1989 p. 7). This would be accomplished because ID presents alternatives to traditional teacher-based instruction and research has shown that utilizing the process creates an effective means of planning classroom instruction. However, at present most classroom teachers have not received formal training in the procedures commonly used by instructional designers. If ID is to help novice teachers move from a stage of being basically reactive (Kerr, 1981) to a point where they become more skilled in handling the "information processing load and decision making during interactive teaching" (Walter, 1984 p. 8), these basic principles must be taught in current, formal, teacher training programs.

Davis and Silvernail (1983) concluded from their national study of recognized curriculum experts that "curriculum design and instructional design skills are viewed as essential parts of teacher preparation programs but that not all of these skills are actually represented in the curricula of such programs." Reiser (1989) goes on to predict by the year 2001 "it is likely that teachers in the public schools will pay more attention to design principles, but it is unlikely that the school systems will employ many instructional designers."

One model for planning effective instruction propounded by Dick and Reiser (1989) consists of the following seven components in order: motivation, objectives, prerequisites, information and examples, practice and feedback, testing, enrichment and remediation. Research suggests that this sequence of events results in the most efficient and effective approach to learning (Dick & Reiser, 1989). It was hypothesized that if teachers - both novice and experienced - were given a short description of these seven components they would be better able to make instructional decisions.

To determine the kind of instructional decisions teachers make when faced with everyday situations, an instrument containing the seven components of an instructional plan with a short description and an additional instrument containing the seven components without a description was used. This was accompanied by 14 typical classroom scenarios for the teachers to read and make a decision regarding which component may be missing.

The Current Study

The purpose of this study was to examine the ability of novice and experienced teachers - not formally trained in ID principles - to identify the components of effective instructional plans. This is in response to a growing trend in the public schools that requires teachers to use, or at least be aware of, some of the basic principles of instructional design.

Method

Subjects

The subjects were 122 undergraduate and graduate education majors from a large southwestern university. Sixty-two subjects were identified as novices (two or less years of teaching experience, $\bar{x} = .23$ years) and sixty were identified as experienced (three or more years of teaching, $\bar{x} = 7.45$ years). Among the novices, 13 were early education majors, 31 elementary, 15 secondary, and three special education. Among the experienced teachers, five held degrees in early education, 17 in elementary, 30 in

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secondary, and eight in special education. All of the subjects were enrolled in a basic teacher preparation class which must be taken at the beginning of their education block. In addition, all of the subjects were volunteers and were not given any extra points for participating.

Materials

An instrument was developed containing 14 typical comments that might be heard from students during or after studying a particular topic. Each of the seven components in an effective instructional plan (Dick & Reiser, 1989) was inferred as missing two different times.

Half of the instruments contained a short description of each of the seven components - motivation, objectives, prerequisites, information and examples, practice and feedback, testing, enrichment and remediation. The remaining half of the instruments gave a listing of the seven components but did not contain any descriptions. A larger number of the test materials than subjects was provided.

Procedures

Materials were distributed so that approximately one half of the subjects would receive an instrument with a short description of the components, plus the 14 comments and the remainder would receive instruments with a only list of the components, plus the 14 comments.

All of the subjects participated in groups within their respective classroom setting. Subjects were randomly assigned to the two conditions - descriptions/no descriptions - based on their seating order. Thirty-two of the novices and 28 of the experienced teachers received test materials with definitions. Thirty of the novices and 32 of the experienced teachers received test materials without definitions.

Subjects were instructed to read each comment and choose which one of the seven components may be missing from the instructional plan. A typical comment reads "I studied and studied, but I never really understood what it was I was supposed to be learning". The missing component in this example shows that the teacher had not made the objective clear to the student. Subjects were informed that there was no time limit and were encouraged to take as long as they felt they needed.

Criterion Measure

An instrument was developed based on the examples given in Planning Effective Instruction (Dick & Reiser, 1989, p. 82-83). Fourteen comments which might be heard from a student in a typical classroom setting were given/constructed to reflect the absence of one of the seven components described as essential to an instructional plan. There were two comments per component. The instrument was given to graduate level instructional design students to test the reliability between the two sets of comments - those created by the author and those used by Dick and Reiser. The resulting measure of equivalence and stability was .99. The number of correct responses (14 possible) to the comments was used as the criterion measure for data analysis.

Design and Data Analysis

The design was a 2(experience) x 2(definition) factorial. An analysis of variance (ANOVA) was used to analyze the data from the experiment.

Results

The mean scores by treatment are shown in Table 1 (the overall mean performance score was 8.21 out of 14 possible). Experienced teachers had a mean score of 9 out of a possible 14. Novice teachers had a mean score of 7.5. The average score for subjects in the two description groups was 8.35 compared to 8.06 for subjects in the no description groups. Items missed by more than 50% of novices pertained to objectives, testing, and enrichment/remediation. The only items missed by more than 50% of experienced teachers pertained to enrichment/remediation.

Insert Table 1 about here

A preliminary analysis was conducted using analysis of variance (ANOVA) procedures to determine the effects of experience and component descriptions on performance. Alpha was set at .05 for all statistical tests.

Insert Table 2 about here

Analysis of the posttest data indicated that giving a short description of each of the seven components did not significantly affect performance $F(3, 118) = .541$ $\underline{p} > .05$.

Results did indicate a significant difference between experienced and novice teachers for identifying the components missing from an effective instructional plan $F(3, 118) = 10.67$, $\underline{p} < .001$.

Discussion

The purpose of this paper is to describe the results of a study conducted to determine the ability of teachers (novice and experienced) to identify basic components of an instructional plan. There are numerous instructional design models to assist in the task of designing classroom instruction and making effective decisions concerning its implementation. These models have long been available to instructional designers, yet teachers are expected to learn ID principles through a process of trial and error in the daily classroom setting. This study provides the basis of an argument for incorporating instructional design principles into preservice and inservice teacher preparation programs.

The results of this study suggest that experienced teachers - without the benefits of formal instructional design training - develop an ability to identify ID problems in an instructional plan. This was evidenced by the significantly higher performance of the experienced teachers in identifying instructional problems, a basic step in instructional design. An obvious explanation might be that teachers do more than merely deliver or implement instruction (Snelbecker, 1987). In fact, Clark and Peterson (1986) determined that teachers average at least one instructional decision every two minutes. With such a significant amount of daily practice in making instructional decisions, it appears that many teachers acquire bits and pieces of the information pertaining to effective instruction that could and should be presented to them in the teacher education programs.

The variable of providing short descriptions of the components appeared to make very little difference to both the novice and experienced teachers. This was probably due to the simplistic nature of the component names themselves. Generally, teachers - novice and experienced alike - have been exposed to such labels as motivation, objective, prerequisites, etc. in their teacher education programs, parent-teacher conferences, work settings or otherwise, and therefore the component names themselves and their meanings were easily understood by the subjects.

Future research in this area might focus on the components that were understood the least - objectives, testing, enrichment/remediation - and therefore make up for the majority of the errors in the results of this study. Also, what is the best method for incorporating instructional design into teacher preparation programs and how much overlap should there be in teacher preparation and instructional design programs?

References

Clark, C. & Peterson, P. (1986). Teachers' thought processes. In M. Wittrock (Ed.), Handbook of research on teaching (3rd ed.) (pp. 255-296). NY: Macmillan.

Davis, D. J., & Silvernail, J. M. (1983, April). Curriculum and instructional design requisites for preservice teacher education: A survey of the ASCD Curriculum Committee. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal.

Dick, W. & Reiser, R. A. (1989). Planning effective instruction. Englewood Cliffs, NJ: Prentice-Hall.

Kerr, S. T. (1981). How teachers design their materials: Implications for instructional design. Instructional Science, 10, 363-378.

Kerr, S. T. (1989). Technology, teachers, and the search for school reform. Educational Technology Research and Development, 37(4), 5-17.

Reiser, R. A. (1988). Instructional designers in public schools and higher education: Predictions for the year 2001. Journal of Instructional Development, 11(3), 3-6.

Snelbecker, G. E. (1987). Instructional design skills for classroom teachers. Journal of Instructional Development, 10(4), 33-40.

Walter, L. J. (1984). A synthesis of research findings on teacher planning and decision making. Using research to improve teacher education: The Nebraska consortium. Teacher Education Monograph, 1 (sp 024 888), 54-63.

Table 1

Mean Performance Scores by Teacher Experience and Presence of Description

	Presence of Description		
Level of Teacher Experience	Description	No Description	Total
Novice			
M	7.59	7.33	7.46
SD	2.08	2.36	2.2
Experienced			
M	9.11	8.78	8.95
SD	1.69	1.68	1.68
Total			
M	8.35	8.06	8.21
SD	2.04	2.15	2.09

Note. n=62 for novices; n=60 for experienced. All scores are out of a maximum of 14 possible.

Table 2

ANOVA Summary Table for Teacher Performance

Source of Variation	SS	df	MS	F	p
Main Effects	44.871	2	22.436	5.516	.005
Definitions	2.201	1	2.201	.541	.463
Experience	43.404	1	43.404	10.672	.001
Definition X Experience	1.886	1	1.886	.464	.497
Explained	46.757	3	15.586	3.832	.012
Within Cells	479.907	118	4.067		
Total	526.664	121	4.353		

Answers to Test Comments

1. E - Practice and Feedback
2. A - Motivation
3. G - Enrichment
4. D - Information and Examples
5. F or E - Testing or Practice and Feedback
6. C - Prerequisites
7. B - Objectives
8. E - Practice and Feedback
9. A - Motivation
10. B - Objectives
11. F - Testing
12. C - Prerequisites
13. D - Information and Examples
14. G - Enrichment and Remediation

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